QUALITY ASSURANCE PROJECT PLAN

Superfund Technical Assessment and Response Team (START IV)
EPA Region 5

Contract No. EP-S5-13-01

U.S. Environmental Protection Agency Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Prepared by:

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June 2016
(Revision 3)

CONTENTS

ACRONYMS AND ABBREVIATIONS

%D	Percent difference
%R	Percent recovery
µCi	Microcurie
µg/kg	Microgram per kilogram
µg/L	Microgram per liter
µg/m	Microgram per cubic meter
µR	Microrad
AAS	Atomic absorption spectrometry
APHA	American Public Health Association
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	Below ground surface
C	Degrees Celsius
CA	Corrective action
CAS	Chemical Abstract Service
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CDD	Chlorinated dibenzo-p-dioxin
CDF	Chlorinated dibenzofuran
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration factor
CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
CVAA	Cold vapor atomic absorption
DQI	Data quality indicator
DQO	Data quality objective
EDD	Electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
ESAT	Environmental Services Assistance Team
FID	Flame ionization detector
GC	Gas chromatography
GC/ECD	Gas chromatography/electron capture detector
GC/MS	Gas chromatography/mass spectrometry
GPR	Ground-penetrating radar
GPS	Global positioning system
HASP	Health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
HPLC	High performance liquid chromatography
HRGC/HRMS	High resolution gas chromatography/high resolution mass spectrometry

HRS	Hazard ranking system
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
ICS	Incident command system
ICV	Initial calibration verification
ID	Identification
ISM	Inorganic Superfund Methods
LCS	Laboratory control sample
LIMS	Laboratory information management system
MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mL	Milliliter
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not applicable or not available
NC	No criteria
NFG	National Functional Guidelines
ng/kg	Nanogram per kilogram
NiCd	Nickel-cadmium
OSC	On-scene coordinator
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PFK	Perfluorokerosene
pg/L	Picogram per liter
PPE	Personal protective equipment
ppm	Part per million
PQO	Project quality objective
PUF	Polyurethane foam
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QCC	Quality control coordinator
QL	Quantitation limit
RPD	Relative percent difference
RRF	Relative response factor
RSCC	Regional sample control coordinator
RSD	Relative standard deviation
RSL	Regional Screening Level

SAP	Sampling and analysis plan
SEDD	Staged electronic data deliverable
SIM	Selected ion monitoring
S/N	Signal-to-noise
SOP	Standard operating procedure
START	Superfund Technical Assessment and Response Team
SVOC	Semivolatile organic compound
TBD	To be determined
TCLP	Toxicity characteristic leaching procedure
TDD	Technical direction document
TOC	Total organic carbon
UFP	Uniform Federal Policy for Implementing Environmental Quality Systems
VOC	Volatile organic compound
XRF	X-ray fluorescence

INTRODUCTION

The ultimate success of an environmental data collection effort depends on the quality of the data collected and used to make decisions. The Quality Assurance Project Plan (QAPP) is a critical planning document for technical support that requires the collection and/or use of environmental data. Thus, the U.S. Environmental Protection Agency's (EPA) policy requires that all environmental data used in decision making be supported by an Agency-approved QAPP developed from a systematic planning process. The QAPP documents how environmental data collection operations are planned and implemented and how the results are assessed. In addition, the QAPP defines the specific quality assurance (QA) and quality control (QC) activities that will be applied to ensure that the environmental data collected are of the type and quality needed for a specific decision or use.

Tetra Tech, Inc. (Tetra Tech) has prepared this QAPP for EPA's Superfund Technical Assessment and Response Team (START) Contract for EPA Region 5. The QAPP is prepared in accordance with the Uniform Federal Policy for Implementing Quality Systems (UFP), and is also consistent with *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)* (EPA 2001 and 2005). Tetra Tech will review the QAPP annually during the START contract and will update the QAPP if necessary.

The intent of this QAPP is to provide a framework for all environmental data collection activities that might occur under the START contract. The QAPP emphasizes the use of proven, validated, and EPA-approved sampling methods and analytical methods such as those in the EPA Contract Laboratory Program (CLP) Statements of Work for organic and inorganic analyses (EPA 2015d and 2015e) and the Test Methods for Evaluating Solid Waste (SW-846) (EPA 2009b). These and other sampling and analytical methods are identified in appropriate sections of this QAPP and will be followed whenever they are sufficient to meet environmental data collection requirements and data quality objectives (DQO).

The purpose of the START contract is to provide assistance to EPA on-scene coordinators (OSC) and other federal officials implementing EPA's responsibilities under the National Response System. EPA is responsible for protecting human health and the environment, its role under the National Response System is to respond to emergencies related to the release or threat of release of oil, hazardous substances, pollutants, and contaminants as well as fire and explosion hazards. EPA is also responsible for coordinating all federal, state, local, and private efforts associated with responding to environmental emergencies. In addition, EPA is required to respond to nuclear, biological, chemical, and radiological events that may result from terrorism or weapons of mass destruction incidents. The START contract also supports other programs, such as hazardous waste site assessment, Brownfields investigations, and cleanups of hazardous waste sites.

The START contract statement of work identifies several activities that include environmental sampling, field and laboratory analysis, or other environmental data collection and are subject to the requirements of this QAPP. These activities include, but are not limited to, the following:

- <u>Response activities</u>. These include emergency response actions, fund-led removal actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and counter-terrorism, federal disaster, and oil spill response actions. Samples collected during response activities must often be analyzed on an emergency, quick turnaround basis. Results will be used to characterize materials released, evaluate hazards to surrounding populations and environments, recommend immediate actions, and evaluate disposal options. Data may also be used to verify that removal action objectives have been met.

- Assessment and inspection activities. These may include a variety of activities conducted under CERCLA such as pre-CERCLIS screening, removal assessments, preliminary assessments, site inspections, site reassessments, expanded site inspections, remedial investigations/feasibility studies, and integrated assessments. In addition, targeted Brownfields assessments may be conducted under this area of the statement of work. Sampling data collected will typically be used to document actual or potential releases of contaminants from a site via groundwater, surface water, soil exposure, or air pathways and to support decisions to conduct removal actions, assessments and evaluations of oil discharges, and preparation of Hazard Ranking System (HRS) packages for listing sites on the National Priorities List. Sampling may also be conducted to support remedial investigations, including preliminary risk assessments, for sites that are accelerated by EPA.

- Technical support activities. Several technical support activities in the START statement of work may require data collection and assessment and will be subject to this QAPP. These activities include multi-media surveys and inspections, treatability studies, engineering evaluations and cost analyses, regional response team support, and enforcement support.

Technical direction documents (TDD) issued under the START contract may require preparation of site-specific sampling and analysis plans (SAP) when environmental data is collected or used. Site-specific SAPs will be prepared in accordance with the requirements of the TDD, and will contain site-specific information that cannot be included in this QAPP. For most TDDs, Tetra Tech will prepare an abbreviated SAP, supplemented by tables and figures, to document site-specific data collection requirements. However, for more complex TDDs, Tetra Tech will prepare a full SAP to document sampling and analysis requirements. Many of the sampling and analytical standard operating procedures (SOP) described in this QAPP will be broadly applicable and can be referenced in site-specific SAPs. However, site-specific SAPs will describe any modifications to these sampling and analytical methods and any additional data collection procedures that are required to meet TDD objectives. This QAPP identifies areas where site-specific information will or might be required, but to the extent possible, common procedures (such as sample handling, chain of custody, data validation, and corrective action) will be included in the site-specific SAPs by reference only.

QAPP WORKSHEET #1
TITLE AND APPROVAL PAGE

Quality Assurance Project Plan for Superfund Technical Assessment and Response Team (START IV), EPA Region 5, Contract No. EP-S5-13-01

Document Title

Tetra Tech, Inc.

Lead Organization

John Dirgo, Tetra Tech

Preparer's Name and Organizational Affiliation

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Preparer's Address, Telephone Number, and E-mail Address

April 21, 2014 (Revision 1 – July 9, 2015;
Revision 2 – January 6, 2016; Revision 3 – June 28, 2016)

Preparation Date (Day/Month/Year)

Kevin Scott	Kevin Scott Digitally signed by: Kevin Scott DN: CN = Kevin Scott email = kevin.scott@tetratech.com C = US O = Tetra Tech OU = EMI Date: 2016.06.30 09:35:00 -06'00'
Tetra Tech Program Manager	Signature/Date
John Dirgo	Digitally signed by: John Dirgo DN: CN = John Dirgo C = US O = Tetra Tech, Inc. OU = EMI Division Date: 2016.06.30 08:31:39 -06'00'
Tetra Tech QA Officer	Signature/Date

EPA Approval Signatures:

Sam Chummar / Project Officer
Signature/Date

Ida Levin / QAPP Reviewer
Signature/Date

QAPP WORKSHEET #2
QAPP IDENTIFYING INFORMATION

1. Identify guidance used to prepare QAPP:

Uniform Federal Policy for Implementing Environmental Quality Systems (UFP) (EPA 2005),
EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5) (EPA 2001)

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. Identify approval entity: EPA Region 5

4. Indicate whether the QAPP is a generic or project-specific QAPP: Generic

5. List dates of scoping sessions that were held: Not applicable (NA)

6. List dates and titles of QAPP documents written for previous work site, if applicable: NA

7. List organizational partners (stakeholders) and connection with lead organization: EPA Region 5, Tetra Tech

8. List data users: EPA Region 5, Tetra Tech

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below: NA

QAPP WORKSHEET #2 (CONTINUED)
QAPP IDENTIFYING INFORMATION

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5.3.3 Amounts and Types of Data Appropriate for Streamlining		

QAPP WORKSHEET #3
DISTRIBUTION LIST

QAPP Recipient	Title	Organization	Telephone Number	E-mail Address
Sam Chummar	Project Officer	EPA Region 5	(312) 886-1434	chummar.sam@epa.gov
Ida Levin	QAPP Reviewer	EPA Region 5	(312) 886-6254	levin.ida@epa.gov
Kevin Scott	Program Manager	Tetra Tech	(312) 201-7739	kevin.scott@tetratech.com
Chris Burns	Deputy Program Manager	Tetra Tech	(321) 201-7719	chris.burns@tetratech.com
John Dirgo	QA Officer	Tetra Tech	(312) 201-7765	john.dirgo@tetratech.com
Carla Buriks	Corporate QA Manager	Tetra Tech	(303) 312-8855	carla.buriks@tetratech.com
Various	Project Managers	Tetra Tech	Various	Various
Tina Reese	QA Manager	Avantti Environmental Group, LLC	(414) 719-1477	treese@avantti-group.com
Patrick Letterer	Project Manager	CT Laboratories, LLC	(608) 356-2760	pletterer@ctlaboratories.com
Mel Turner	Equipment Manager	Field Environmental Instruments, Inc.	(412) 436-2600	MTurner@fieldenvironmental.com
Nancy Posavatz	Project Manager	The Mannik & Smith Group, Inc.	(231) 929-7330	NPosavatz@manniksmithgroup.com
Josh Randall	Project Manager	Quality Environmental Professionals, Inc.	(317) 351-4255	jrandall@qepi.com
Mike Browning	Project Manager	Seagull Environmental Technologies, Inc.	(248) 259-4761	mbrowning@seagullenvirotech.com

Notes:

QA Quality assurance
QAPP Quality assurance project plan
TBD To be determined

Requirements:

This contract-level QAPP will be distributed to the individuals listed in Worksheet #3. A current version of the contract-level QAPP will also be maintained on a shared network drive in Tetra Tech's Chicago office. The QAPP will be available for review by all Tetra Tech team personnel working on the START contract.

QAPP WORKSHEET #4
PROJECT PERSONNEL SIGN-OFF SHEET

Project Personnel	Organization	Title	Telephone No.	Signature	Date Reviewed
John Dirgo	Tetra Tech	QA Officer	(312) 201-7765		
TBD	Tetra Tech	Project Manager			
TBD	Tetra Tech	Field Team Leader			
TBD	Tetra Tech	Analytical Coordinator			
TBD	Tetra Tech	Quality Control Coordinator			
TBD	Tetra Tech	Sample Custodian			
TBD	Tetra Tech	Chemist			
TBD	Tetra Tech	Technical Staff			
Drilling Subcontractor	TBD	Project Manager			
Surveying Subcontractor	TBD	Project Manager			
Subcontracted Laboratory	TBD	Project Manager			

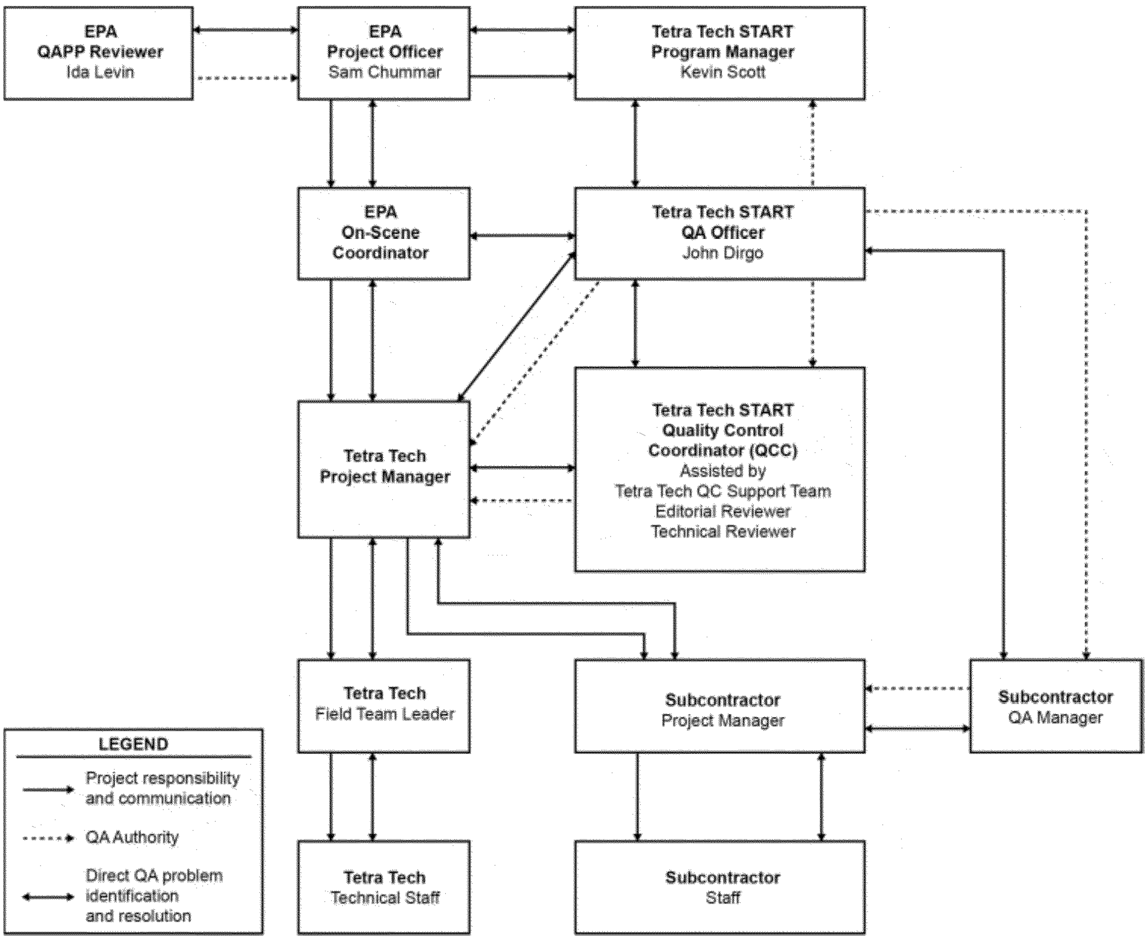
Notes:

QA Quality assurance
TBD To be determined

Requirements:

Worksheet #4 illustrates the typical distribution list for a site-specific sampling and analysis plan (SAP) or site-specific quality assurance project plan (QAPP). Personnel working on START projects are required to review site-specific SAPs and QAPPs and to sign Worksheet #4 after they have finished their reviews.

QAPP WORKSHEET #5
PROJECT ORGANIZATION CHART



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QAPP WORKSHEET #6
COMMUNICATION PATHWAYS

Communication Drivers	Responsible Entity	Name	Telephone No.	Procedure (Timing, Pathways, etc.)
Point of contact with EPA OSC	Project Manager	TBD		Forward all materials and information about the project to the EPA OSC.
Manage all project phases	Project Manager	TBD		Communicate information to project team (including subcontractors) on a timely basis. Notify EPA OSC by telephone or e-mail of any significant issues. Direct field team and facilitate communication with analytical coordinator. Deliver all laboratory data packages to chemist for final review and/or validation.
Daily field progress report	Field Team Leader	TBD		Conduct specific field investigation tasks, direct field activities of subcontractors, and provide daily communication with project manager and sample custodian.
Manage field sample organization and delivery to laboratories	Sample Custodian	TBD		Ensure field staff is collecting samples in proper containers, observing holding times, and properly packaging and preparing samples for shipment. Coordinate daily with analytical coordinator concerning sample quantities and delivery locations and dates. Communicate daily with field staff and project manager regarding any laboratory issues.
Point of contact with EPA Region 5 Regional Sample Control Coordinator (RSCC) and subcontracted laboratories	Analytical Coordinator	TBD		Contact the RSCC or subcontracted laboratory before each sampling event to schedule laboratory services. Notify sample custodian and project manager of any laboratory issues. Track all laboratory data deliveries. Notify and forward data to project manager.
Release of analytical data	Chemist	TBD		No analytical data can be released until chemist has completed validation and approved data for release.
Report of laboratory data quality issues	Laboratory QA Officer	TBD		QA/QC issues with project field samples will be reported by the laboratory QA officer to the RSCC (for CLP or CRL) or to the Tetra Tech analytical coordinator (for subcontracted laboratories).

Notes:

CLP	Contract Laboratory Program
CRL	Central Regional laboratory
EPA	U.S. Environmental Protection Agency
OSC	On-scene coordinator
QA	Quality assurance
QC	Quality control
RSCC	Regional Sample Control Coordinator
TBD	To be determined

QAPP WORKSHEET #7
PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

Name	Title	Organization/ Affiliation	Responsibilities	Education and Experience Qualifications
John Dirgo	QA Officer	Tetra Tech	Provides QA/QC oversight	Sc.D. in Environmental Health Sciences 35 years of experience
TBD	Project Manager	Tetra Tech	Manages project; coordinates between lead agency and subcontractors; coordinates laboratory data deliverables from analytical coordinator to project chemist; manages field staff	
TBD	Field Team Leader	Tetra Tech	Supervises field sampling and coordinates field activities; reports daily to project manager while conducting field activities	
TBD	Technical Staff	Tetra Tech	Prepares QAPP; implements field plan; verifies sample processing, packaging, and shipping	
TBD	Quality Control Coordinator	Tetra Tech	Reviews project deliverables; provides QA/QC support to project manager	
TBD	Analytical Coordinator	Tetra Tech	Coordinates sample scheduling; verifies sample chain of custody; reviews laboratory results; notifies sample custodian and project manager of any issues	
TBD	Chemist	Tetra Tech	Validates analytical data produced by laboratories	
TBD	Analytical laboratory	CLP, CRL, or Subcontractor	Analyzes samples collected by field team	
TBD	Drillers	Subcontractor	Provides subsurface drilling	
TBD	Surveyors	Subcontractor	Provides survey of monitoring wells locations at the site	

Notes:

CLP Contract Laboratory Program
CRL Central Regional Laboratory
QA Quality assurance
QC Quality control
QAPP Quality assurance project plan
TBD To be determined

QAPP WORKSHEET #8
SPECIAL PERSONNEL TRAINING REQUIREMENTS

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Field Staff	40-hour and 8-hour refresher –OSHA HAZWOPER training	Various	Various	Tetra Tech	Tetra Tech	Corporate human resources office
Subcontractors	40-hour OSHA HAZWOPER training	TBD	TBD	Drillers, surveyors, and other on-site subcontractors	TBD	As specified in subcontract agreements

Notes:

HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
OSHA	Occupational Safety and Health Administration
TBD	To be determined

Requirements:

The primary training requirements for Tetra Tech personnel engaged in field activities are the emergency response and hazardous waste operations training requirements defined in 29 CFR 1910.120. In addition, Tetra Tech personnel are trained on the Incident Command System (ICS) and on the operation and use of monitoring equipment. Additional specialized training or certification related to environmental data collection might be required if (1) specifically called for in a technical direction document (TDD) or (2) identified as necessary by Tetra Tech in responding to a TDD. In these situations, Tetra Tech will address training and certification needs in the site-specific sampling and analysis plan (SAP). The SAP will identify Tetra Tech personnel that meet the special training or certification requirements; provide documentation of the training or certification; and describe how these personnel will be assigned to the project. If Tetra Tech personnel do not meet special training or certification requirements, the SAP will briefly describe how the necessary skills will be acquired and applied to the project.

QAPP WORKSHEET #9
PROJECT SCOPING SESSION PARTICIPANTS SHEET

<table>
<tr><td>Project Name</td><td colspan="2"></td><td>Site Name</td><td colspan="2"></td></tr>
<tr><td>Projected Date(s) of Sampling</td><td colspan="2"></td><td>Site Location</td><td colspan="2"></td></tr>
<tr><td>Project Manager</td><td colspan="5"></td></tr>
<tr><td>Date of Session</td><td colspan="5"></td></tr>
<tr><td>Scoping Session Purpose:</td><td colspan="5">Kick-off meeting discuss site work.</td></tr>
<tr><td>Name</td><td>Title</td><td>Affiliation</td><td>Phone #</td><td>E-Mail Address</td><td>Project Role</td></tr>
<tr><td>TBD</td><td>OSC</td><td>EPA Region 5</td><td></td><td></td><td>OSC</td></tr>
<tr><td>TBD</td><td>Project Manager</td><td>Tetra Tech</td><td></td><td></td><td>Project Manager</td></tr>
<tr><td>Kevin Scott</td><td>Program Manager</td><td>Tetra Tech</td><td>(312) 201-7739</td><td>kevin.scott@tetratech.com</td><td>Program Manager</td></tr>
<tr><td colspan="6"><u>Comments/Decisions</u>: Insert a description of the scoping session and associated decisions</td></tr>
</table>

Notes:

EPA U.S. Environmental Protection Agency
OSC On-scene coordinator
TBD To be determined

QAPP WORKSHEET #10
PROBLEM DEFINITION

The problem to be addressed by the project:

For site-specific sampling and analysis plans (SAP) prepared for the START contract, Tetra Tech will use the data quality objectives (DQO) process to (1) clarify study objectives and decisions to be made based on the data collected; (2) define the most appropriate types of data to collect; (3) determine the most appropriate conditions for collecting the data; and (4) specify performance or acceptance criteria that will be used as the basis for establishing the quantity and quality of data needed to support the decision. The DQO process consists of the following seven steps:

- Step 1—State the Problem. The purposes of step 1 are to summarize the problem that will require environmental data collection and to identify resources available to resolve the problem. The description of the problem should include the regulatory and programmatic context of the problem as well as appropriate action levels for evaluating and responding to the problem. The primary output of step 1 is a complete description of the problem. Information developed during step 1 (such as site background information and previous sampling results) can be used to complete the site-specific SAP.
- Step 2—Identify the Goals of the Study. The purpose of step 2 is to identify the key questions the study will address and decisions that will be made based on the environmental data collected. Examples of decisions to be made include whether a release poses a threat to human health and the environment, whether contaminant concentrations at a site exceed preliminary remediation goals, or whether cleanup levels have been achieved. Step 2 also identifies the actions that might be taken as a result of the decisions.
- Step 3—Identify Information. During step 3, the information needed to make decisions and resolve key study questions is identified. This information can include previously collected data and new environmental measurements. This step will determine whether decisions can be made based on monitoring, modeling, or a combination of both approaches. Step 3 will also identify the types of samples to be collected, specific contaminants to be measured, and potential sampling and analysis methods. Information developed in step 3 can be used as input for the site-specific SAP.
- Step 4—Define the Boundaries of the Study. This step defines the spatial and temporal boundaries of the study, considering such factors as site-specific contaminants, potential migration pathways for contamination, physical characteristics of the site, and future site use. Spatial boundaries can include property boundaries, solid waste management units, or exposure areas. Temporal boundaries can include the time frame over which the study data must apply as well as the most appropriate times for sample collection. For example, if a decision to be made is related to air concentrations of volatile organic compounds (VOC), it would be more appropriate to collect data during warmer weather when VOCs are more likely to be released.
- Step 5—Develop the Analytic Approach. The purpose of this step is to define specific parameters of interest, specify action levels for these parameters, integrate this information with outputs from previous DQO steps, and describe a logical basis for choosing appropriate actions based on study results. An example of a decision that might be made based on study results is "If the average vinyl chloride concentration in downgradient wells exceeds the maximum contaminant level (MCL), corrective action for groundwater will be required."
- Step 6—Specify Performance or Acceptance Criteria. Step 6 evaluates the consequences of making incorrect decisions based on the data collected. For example, at a site with a large number of nearby receptors, EPA may determine that the threat of health effects is a more serious consequence than spending extra resources for remedial action. In this case, the consequences of incorrectly concluding that contaminant concentrations do not exceed action levels are more serious than the consequences of incorrectly concluding that action levels are exceeded. By taking this information into account, a sampling plan can be developed that provides an acceptable level of uncertainty.

QAPP WORKSHEET #10 (CONTINUED)
PROBLEM DEFINITION

• Step 7—Develop the Plan for Obtaining Data. The purpose of step 7 is to develop the most resource-effective sampling and analysis approach to generate data that will satisfy the DQOs specified in the previous steps. These design elements are documented in the site-specific SAP and include sample types, sample collection methods, sampling locations, analytical methods, and quality assurance and quality control requirements. All seven steps of the DQO process may not be applicable to all environmental data collection activities. Examples include activities where specific decisions cannot be identified or studies that are exploratory in nature. In these situations, Tetra Tech will use the steps of the DQO process that are applicable to help plan the data collection effort.
The environmental questions being asked: See DQO Steps 2 and 5 above.
Observations from any site reconnaissance reports: Site-specific SAPs will summarize any important observations from site reconnaissance reports that have been used to develop the sampling and analysis approach.
A synopsis of secondary data or information from site reports: See Worksheet #13 for a discussion of secondary data.
The possible classes of contaminants and the affected matrices: See DQO Steps 3 and 4 above.
Project decision conditions ("If…, then…" statements): See DQO Step 5 above.

QAPP WORKSHEET #11
PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

Who will use the data: EPA Region 5 and Tetra Tech will use the data.
What will the data be used for? Data use will depend on the specific requirements of each technical direction document (TDD) and should be explained in the site-specific sampling and analysis plan (SAP).
What types of data are needed (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)? Site-specific SAPs should include a table listing the sample types and matrices, sampling locations, field screening parameters, and other pertinent information. See DQO Step 3 in Worksheet #10 and Worksheets #18 and 20 for the type of information that will be included.
How "good" do the data need to be in order to support the environmental decision? Data quality depends on the intended use of the data and the decisions to be made based on the data. For projects that require data collection, Tetra Tech will follow EPA's data quality objectives (DQO) process as described in *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4) (EPA 2006a). The DQO process provides a systematic procedure for defining the criteria that a data collection design should satisfy and is a preliminary step for developing site-specific SAPs. See DQO Step 6 in Worksheet #10. The quality of the data is determined by establishing criteria for performance measures listed in Worksheet #12. Also, contaminant-specific action limits and reporting limits the environmental media likely to be sampled and the analytical methods likely to be used under the START contract are specified in Worksheet #15.
How much data are needed (number of samples for each analytical group, matrix, and concentration)? Site-specific SAPs should include a table listing the sample types and matrices, sampling locations, field screening parameters, and other pertinent information. See DQO Step 7 in Worksheet #10. See Worksheets #18 and 20 for the type of information that will be included.
Where, when, and how should the data be collected/generated? For site-specific SAPs prepared for the START contract, Tetra Tech will use the DQO process to (1) clarify study objectives and decisions to be made based on the data collected; (2) define the most appropriate types of data to collect; (3) determine the most appropriate conditions for collecting the data; and (4) specify performance or acceptance criteria that will be used as the basis for establishing the quantity and quality of data needed to support the decision. See DQO Step 3, 4, and 7 in Worksheet #10.
Who will collect and generate the data? Tetra Tech and its team subcontractors will collect all samples required under the START contract. Samples will be analyzed by EPA Contract Laboratory Program (CLP) laboratories, the EPA Region 5 Central Regional Laboratory (CRL), or subcontracted laboratories. See Worksheet #30 for additional information about analytical services.
How will the data be reported? Worksheet #27 has additional information about reporting of field data. Laboratory data will be reported by analytical laboratories using standard data reporting techniques. Data will be reported in electronic and hard-copy formats. Worksheets #29 and 30 provide additional information about reporting requirements for laboratory data.

QAPP WORKSHEET #11 (CONTINUED)
PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

How will the data be archived? Electronic and hard copies of CLP and CRL analytical data will be archived by the individual laboratories. Electronic and hard copies of subcontracted laboratory data will be archived by the Tetra Tech project manager. Field data (electronic data, logbooks, and field data sheets) will be maintained at Tetra Tech's Chicago office. Tetra Tech will also provide 10-year data storage. Worksheet #29 provides further information about document and records management under the START contract.

QAPP WORKSHEET #12
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	VOCs, TCLP VOCs
Concentration Level[a]	Trace, Low

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A2	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A1, A2	Accuracy/ Bias-Contamination	VOCs < QL	Trip blank	S & A
Various	A1, A2	Accuracy/ Bias-Contamination	VOCs < QL	Rinsate blank	S & A
Various	A1, A2	Accuracy/Bias	1,1-Dichloroethene: 61-145 %R TCE: 71-120 %R Benzene: 76-127 %R Toluene: 76-125 %R Chlorobenzene: 75-130 %R	MS/MSD	S & A
Various	A1, A2	Precision	1,1-Dichloroethene: 14% RPD TCE: 14% RPD Benzene: 11% RPD Toluene: 13% RPD Chlorobenzene: 13% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	VOCs, TCLP VOCs
Concentration Level[a]	Trace, Low

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A2	Accuracy	Vinyl chloride-d_3: 60-135 %R Chloroethane-d_5: 70-130 %R 1,1-Dichloroethene-d_2: 60-125 %R 2-Butanone-d_5: 40-130 %R Chloroform-d: 70-125 %R 1,2-Dichloroethane-d_4: 70-125 %R Benzene-d_6: 70-125 %R 1,2-Dichloropropane-d_6: 70-120 %R Toluene-d_8 : 80-120 %R Trans-1,3-Dichloropropene-d_4 : 60-125 %R 2-Hexanone-d_5 : 45-130 %R 1,1,2,2-Tetrachloroethane-d_2: 65-120 %R 1,2-Dichlorobenzene-d_4: 80-120 %R	Deuterated monitoring compounds (surrogates)	A
Various	A1, A2	Accuracy/ Bias-Contamination	VOCs < QL	Method blank	A
Various	A1, A2	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level[a]	SIM, Low

Sampling Procedure[b]	**Analytical Method SOP**[c]	**DQIs**	**Measurement Performance Criteria**[d]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A1, A5	Precision	RPD ≤ 50%	Field Duplicate	S & A
Various	A1, A5	Accuracy/Bias	Phenol: 12-110 %R 2-Chlorophenol: 27-123 %R N-Nitrosodi-n-propylamine: 41-116 %R 4-Chloro-3-methylphenol: 23-97 %R Acenaphthene: 46-118 %R 4-Nitrophenol: 10-80 %R 2,4-Dinitrotoluene: 24-96 %R Pentachlorophenol: 9-103 %R Pyrene: 26-127 %R	MS/MSD	S & A
Various	A1, A5	Precision	Phenol: 42% RPD 2-Chlorophenol: 40% RPD N-Nitrosodi-n-propylamine: 38% RPD 4-Chloro-3-methylphenol: 42% RPD Acenaphthene: 31% RPD 4-Nitrophenol: 50% RPD 2,4-Dinitrotoluene: 38% RPD Pentachlorophenol: 50% RPD Pyrene: 31% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level[a]	SIM, Low

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A5	Accuracy	1,4-Dioxane-d_8: 40-110 %R Phenol-d_5: 10-130 %R Bis(2-chloroethyl)ether-d_8: 25-120 %R 2-Chlorophenol-d_4: 20-130 %R 4-Methylphenol-d_8: 25-125 %R Nitrobenzene-d_5: 20-125 %R 2-Nitrophenol-d_4: 20-130 %R 2,4-Dichlorophenol-d_3: 20-120 %R 4-Chloroaniline-d_4: 1-146 %R Dimethylphthalate-d_6: 25-130 %R Acenaphthylene-d_8: 10-130 %R 4-Nitrophenol-d_4: 10-150 %R Fluorene-d_{10}: 25-125 %R 4,6-Dinitro-2-methylphenol-d_2: 10-130 %R Anthracene-d_{10}: 25-130 %R Pyrene-d_{10}: 15-130 %R Benzo(a)pyrene-d_{12}: 20-130 %R Fluoranthene-d_{10}: 30-130 %R 2-Methylnaphthalene-d_{10}: 30-130 %R	Deuterated monitoring compounds (surrogates)	A
Various	A1, A5	Accuracy/ Bias-Contamination	SVOCs < QL	Method blank	A
Various	A1, A5	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	Herbicides
Concentration Level[a]	NA

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A8	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A8	Accuracy/ Bias-Contamination	Herbicides < QL	Rinsate blank	S & A
Various	A8	Accuracy/Bias	All herbicides: 70-130 %R	MS	S & A
Various	A8	Precision	All herbicides: < 35% RPD	Laboratory duplicate	A
Various	A8	Accuracy	2,4-Dichlorophenylacetic acid: 70-130 %R	Surrogate spike	A
Various	A8	Accuracy/ Bias-Contamination	Herbicides < QL	Method blank	A
Various	A8	Accuracy/Bias	All herbicides: 70-130 %R	LCS	A
Various	A8	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	Pesticides
Concentration Level[a]	NA

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A7	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A1, A7	Accuracy/ Bias-Contamination	Pesticides < QL	Rinsate blank	S & A
Various	A1, A7	Accuracy/Bias	gamma-BHC (Lindane): 56-123 %R Heptachlor: 40-131 %R Aldrin: 40-120 %R Dieldrin: 52-126 %R Endrin: 56-121 %R 4,4'-DDT: 38-127 %R	MS/MSD	S & A
Various	A1, A7	Precision	gamma-BHC (Lindane): 15 %RPD Heptachlor: 20 %RPD Aldrin: 22 %RPD Dieldrin: 18 %RPD Endrin: 21 %RPD 4,4'-DDT: 27 %RPD	MS/MSD	S & A
Various	A1, A7	Accuracy	Tetrachloro-m-xylene: 30-150 %R Decachlorobiphenyl: 30-150 %R	Surrogate spike	A
Various	A1, A7	Accuracy/ Bias-Contamination	Pesticides < QL	Method blank	A
Various	A1, A7	Accuracy/Bias	gamma-BHC (Lindane): 50-120 %R Heptachlor epoxide: 50-150 %R Dieldrin: 30-130 %R 4,4'-DDE: 50-150 %R Endrin: 50-120 %R Endosulfan sulfate: 50-120 %R gamma-Chlordane: 30-130%R	LCS	A
Various	A1, A7	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	PCBs
Concentration Level[a]	NA

Sampling Procedure[b]	**Analytical Method SOP**[c]	**DQIs**	**Measurement Performance Criteria**[d]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A1, A6	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A1, A6	Accuracy/ Bias-Contamination	PCBs < QL	Rinsate blank	S & A
Various	A1, A6	Accuracy/Bias	Aroclor-1016: 29-135 %R Aroclor-1260: 29-135 %R	MS/MSD	S & A
Various	A1, A6	Precision	Aroclor-1016: 15% RPD Aroclor-1260: 20% RPD	MS/MSD	S & A
Various	A1, A6	Accuracy	Tetrachloro-m-xylene: 30-150 %R Decachlorobiphenyl: 30-150 %R	Surrogate spike	A
Various	A1, A6	Accuracy/ Bias-Contamination	PCBs < QL	Method blank	A
Various	A1, A6	Accuracy/Bias	Aroclor-1016: 50-150 %R Aroclor-1260: 50-150 %R	LCS	A
Various	A1, A6	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	Dioxins/Furans
Concentration Level[a]	NA

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A9, A10	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A9, A10	Accuracy/ Bias- Contamination	Dioxins/furans < QL	Rinsate blank	S & A
Various	A9, A10	Accuracy/Bias	2378-TCDD: 67-158 %R 2378-TCDF: 75-158 %R 12378-PeCDF: 80-134 %R 12378-PeCDD: 70-142 %R 23478-PeCDF: 68-160 %R 123478-HxCDF: 72-134 %R 123678-HxCDF: 84-130 %R 123478-HxCDD: 70-164 %R 123678-HxCDD: 76-134 %R 234678-HxCDF: 70-156 %R 123789-HxCDF: 78-130 %R 1234678-HpCDF: 82-132 %R 1234678-HpCDD: 70-140 %R 1234789-HpCDF: 78-138 %R OCDD: 78-144 %R OCDF: 63-170 %R	LCS	A
Various	A9, A10	Accuracy/ Bias- Contamination	Dioxins/furans < QL	Method blank	A
Various	A9, A10	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Water
Analytical Group	Metals, Mercury, Cyanide, TCLP Metals/CLP
Concentration Level[a]	ICP-AES or ICP-MS for Metals, NA for Mercury and Cyanide

Sampling Procedure[b]	**Analytical Method SOP[c]**	**DQIs**	**Measurement Performance Criteria[d]**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A11, A12, A13, A14, A16	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A11, A12, A13, A14, A16	Accuracy/Bias-contamination	Metals, cyanide < QL	Rinsate blank	S & A
Various	A11, A12, A13, A14, A16	Accuracy	All metals, cyanide: 75-125 %R	MS	A
Various	A11, A12, A13, A14, A16	Precision	All metals, cyanide: < 20% RPD	Laboratory duplicate	A
Various	A11, A12, A13, A14, A16	Sensitivity/ Contamination	Metals, cyanide < QL	Method blank	A
Various	A11, A12, A13, A14, A16	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	VOCs, TCLP VOCs
Concentration Level[a]	Low, Medium

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A2	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A1, A2	Accuracy/ Bias-Contamination	VOCs < QL	Rinsate blank	S & A
Various	A1, A2	Accuracy/Bias	1,1-Dichloroethene: 59-172 %R TCE: 62-137 %R Benzene: 66-142 %R Toluene: 59-139 %R Chlorobenzene: 60-133 %R	MS/MSD	S & A
Various	A1, A2	Precision	1,1-Dichloroethene: 22% RPD TCE: 24% RPD Benzene: 21% RPD Toluene: 21% RPD Chlorobenzene: 21% RPD	MS/MSD	S & A
Various	A1, A2	Accuracy	Vinyl chloride-d_3: 30-150 %R Chloroethane-d_5: 30-150 %R 1,1-Dichloroethene-d_2: 45-110 %R 2-Butanone-d_5: 20-135 %R Chloroform-d: 40-150 %R 1,2-Dichloroethane-d_4: 70-130 %R Benzene-d_6: 20-135 %R 1,2-Dichloropropane-d_6: 70-120 %R Toluene-d_8: 30-130 %R 1,1,2,2-Tetrachloroethane-d_2: 45-120 %R Trans-1,3-Dichloropropene-d_4: 35-135 %R 2-Hexanone-d_5: 20-135 %R 1,2-Dichlorobenzene-d_4: 75-120 %R	Deuterated monitoring compounds (surrogates)	A
Various	A1, A2	Accuracy/ Bias-Contamination	VOCs < QL	Method blank	A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	VOCs, TCLP VOCs
Concentration Level[a]	Low, Medium

Sampling Procedure[b]	**Analytical Method SOP**[c]	**DQIs**	**Measurement Performance Criteria**[d]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A1, A2	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level[a]	SIM, Low, Medium

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A5	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A1, A5	Accuracy/ Bias-Contamination	SVOCs < QL	Rinsate blank	S & A
Various	A1, A5	Accuracy/Bias	Phenol: 26-90 %R 2-Chlorophenol: 25-102 %R N-Nitroso-di-n-propylamine: 41-126 %R 4-Chloro-3-methylphenol: 26-103 %R Acenaphthene: 31-137 %R 4-Nitrophenol: 11-114 %R 2,4-Dinitrotoluene: 28-89 %R Pentachlorophenol: 17-109 %R Pyrene: 35-142 %R	MS/MSD	S & A
Various	A1, A5	Precision	Phenol: 35% RPD 2-Chlorophenol: 50% RPD N-Nitroso-di-n-propylamine: 38% RPD 4-Chloro-3-methylphenol: 33% RPD Acenaphthene: 19% RPD 4-Nitrophenol: 50% RPD 2,4-Dinitrotoluene: 47% RPD Pentachlorophenol: 47% RPD Pyrene: 36% RPD	MS/MSD	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level[a]	SIM, Low, Medium

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A1, A5	Accuracy	1,4-Dioxane-d8: 40-110 %R Phenol-d5: 10-130 %R Bis(2-Chloroethyl)ether-d8: 10-150 %R 2-Chlorophenol-d4: 15-120 %R 4-Methylphenol-d8: 10-140 %R Nitrobenzene-d5: 10-135 %R 2-Nitrophenol-d4: 10-120 %R 2,4-Dichlorophenol-d3: 10-140 %R 4-Chloroaniline-d4: 1-145 %R Dimethylphthalate-d6: 10-145 %R Acenaphthylene-d8: 15-120 %R 4-Nitrophenol-d4: 10-150 %R Fluorene-d10: 20-140 %R 4,6-Dinitro-2-methylphenol-d2: 10-130 %R Anthracene-d10: 10-150 %R Pyrene-d10: 10-130 %R Benzo(a)pyrene-d12: 10-140 %R Fluoranthene-d10: 30-130 %R 2-Methylnaphthalene-d10: 20-140 %R	Deuterated monitoring compounds (surrogates)	A
Various	A1, A5	Accuracy/Bias-Contamination	SVOCs < QL	Method blank	A
Various	A1, A5	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S&A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	Pesticides
Concentration Level[a]	NA

Sampling Procedure[b]	**Analytical Method SOP**[c]	**DQIs**	**Measurement Performance Criteria**[d]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A1, A7	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A1, A7	Accuracy/ Bias-Contamination	Pesticides < QL	Rinsate blank	S & A
Various	A1, A7	Accuracy/Bias	gamma-BHC (Lindane): 46-127 %R Heptachlor: 35-130 %R Aldrin: 34-132 %R Dieldrin: 31-134 %R Endrin: 42-139 %R 4,4'-DDT: 23-134 %R	MS/MSD	S & A
Various	A1, A7	Precision	gamma-BHC (Lindane): 50 %RPD Heptachlor: 31 %RPD Aldrin: 43 %RPD Dieldrin: 38 %RPD Endrin: 45 %RPD 4,4'-DDT: 50 %RPD	MS/MSD	S & A
Various	A1, A7	Accuracy	Tetrachloro-m-xylene: 30-150 %R Decachlorobiphenyl: 30-150 %R	Surrogate spike	A
Various	A1, A7	Accuracy/ Bias-Contamination	Pesticides < QL	Method blank	A
Various	A1, A7	Accuracy/Bias	gamma-BHC (Lindane): 50-120 %R Heptachlor epoxide: 50-150 %R Dieldrin: 30-130 %R 4,4'-DDE: 50-150 %R Endrin: 50-120 %R Endosulfan sulfate: 50-120 %R gamma-Chlordane: 30-130 %R	LCS	A
Various	A1, A7	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	Herbicides
Concentration Level[a]	NA

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A8	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A8	Accuracy/ Bias- Contamination	Herbicides < QL	Rinsate blank	S & A
Various	A8	Accuracy/Bias	All herbicides: 70-130 %R	MS	S & A
Various	A8	Accuracy	2,4-Dichlorophenylacetic acid: 70-130 %R	Surrogate spike	A
Various	A8	Precision	All herbicides: < 50% RPD	Laboratory duplicate	A
Various	A8	Accuracy/ Bias- Contamination	Herbicides < QL	Method blank	A
Various	A8	Accuracy/Bias	All herbicides: 70-130 %R	LCS	A
Various	A8	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	PCBs
Concentration Level[a]	NA

Sampling Procedure[b]	**Analytical Method SOP[c]**	**DQIs**	**Measurement Performance Criteria[d]**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A1, A6	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A1, A6	Accuracy/ Bias- Contamination	PCBs < QL	Rinsate blank	S & A
Various	A1, A6	Accuracy/Bias	Aroclor-1016: 29-135 %R Aroclor-1260: 29-135 %R	MS/MSD	S & A
Various	A1, A6	Precision	Aroclor-1016: 15% RPD Aroclor-1260: 20% RPD	MS/MSD	S & A
Various	A1, A6	Accuracy	Tetrachloro-m-xylene: 30-150 %R Decachlorobiphenyl: 30-150 %R	Surrogate spike	A
Various	A1, A6	Accuracy/ Bias- Contamination	PCBs < QL	Method blank	A
Various	A1, A6	Accuracy/Bias	Aroclor-1016: 50-150 %R Aroclor-1260: 50-150 %R	LCS	A
Various	A1, A6	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	Dioxins/Furans
Concentration Level[a]	NA

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A9, A10	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A9, A10	Accuracy/ Bias-Contamination	Dioxins/furans < QL	Rinsate blank	S & A
Various	A9, A10	Accuracy/Bias	2378-TCDD: 67-158 %R 2378-TCDF: 75-158 %R 12378-PeCDF: 80-134 %R 12378-PeCDD: 70-142 %R 23478-PeCDF: 68-160 %R 123478-HxCDF: 72-134 %R 123678-HxCDF: 84-130 %R 123478-HxCDD: 70-164 %R 123678-HxCDD: 76-134 %R 234678-HxCDF: 70-156 %R 123789-HxCDF: 78-130 %R 1234678-HpCDF: 82-132 %R 1234678-HpCDD: 70-140 %R 1234789-HpCDF: 78-138 %R OCDD: 78-144 %R OCDF: 63-170 %R	LCS	A
Various	A9, A10	Accuracy/ Bias-Contamination	Dioxins/furans < QL	Method blank	A
Various	A9, A10	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Soil/Sediment/Waste
Analytical Group	TAL Metals, Mercury, Cyanide, TCLP Metals/CLP
Concentration Level[a]	ICP-AES or ICP-MS for Metals, NA for Mercury and Cyanide

Sampling Procedure[b]	**Analytical Method SOP**[c]	**DQIs**	**Measurement Performance Criteria**[d]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
Various	A11, A12, A13, A15, A16	Precision	RPD ≤ 70%	Field duplicate	S & A
Various	A11, A12, A13, A15, A16	Accuracy/Bias-contamination	Metals, cyanide < QL	Rinsate blank	S & A
Various	A11, A12, A13, A15, A16	Accuracy/Bias	All metals, cyanide: 75-125 %R	Matrix spike	A
Various	A11, A12, A13, A15, A16	Precision	All metals, cyanide: < 20% RPD	Laboratory duplicate	A
Various	A11, A12, A13, A15, A16	Accuracy/Bias, Contamination	Metals, cyanide < QL	Method blank	A
Various	A11, A12, A13, A15, A16	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Matrix	Air/Soil Gas
Analytical Group	VOCs
Concentration Level[a]	SIM, Scan

Sampling Procedure[b]	Analytical Method SOP[c]	DQIs	Measurement Performance Criteria[d]	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Various	A3, A4	Precision	RPD ≤ 50%	Field duplicate	S & A
Various	A3, A4	Accuracy	Bromochloromethane, 60-140 %R Chlorobenzene-d5, 60-140 %R 1,4-Difluorobenzene, 60-140 %R	Internal standards	A
Various	A3, A4	Accuracy	70-130 % R	Laboratory control sample	A
Various	A3, A4	Accuracy/ Bias-Contamination	VOC < QL	Method blank	A
Various	A3, A4	Precision	RPD <30%	Laboratory Duplicate	A
Various	A3, A4	Completeness	≥ 90%	Data completeness defined as data not qualified as rejected after validation	S & A

QAPP WORKSHEET #12 (CONTINUED)
MEASUREMENT PERFORMANCE CRITERIA

Notes:

a	Concentration levels refer to specific contract-required quantitation limits defined by EPA's Contract Laboratory Program (CLP). See the CLP web site for additional information: http://www2.epa.gov/clp/what-are-available-analytical-services-within-superfund-contract-laboratory-program
b	Sampling SOPs are listed in QAPP Worksheet #21
c	Analytical method reference numbers are listed QAPP Worksheet #23
d	The measurement performance criteria listed for VOCs, SVOCs, pesticides, herbicides, PCBs, dioxins/furans, metals, and cyanide are from EPA CLP statements of work. Subcontracted laboratories may have different laboratory-specific measurement performance criteria.

DQI	Data quality indicator
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
LCS	Laboratory control sample
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not applicable
PCB	Polychlorinated biphenyl
QL	Quantitation limit
%R	Percent recovery
RPD	Relative percent difference
SIM	Selected ion monitoring
SOP	Standard operating procedure
SVOC	Semivolatile organic compound
TCLP	Toxicity characteristic leaching procedure
VOC	Volatile organic compound

QAPP WORKSHEET #13
SECONDARY DATA CRITERIA AND LIMITATIONS

Secondary Data	Data Source (Report Title and Date)	Data Generator (Originating Organization, Data Types, Data Generation and Collection Dates)	How Data Will Be Used	Limitations on Data Use

Requirements:

Some work under the START contract may rely on secondary data from other sources such as reports, databases, spreadsheets, and literature files. When secondary data is of critical importance in supporting sampling and analytical measurements, quality requirements will be outlined in the site-specific sampling and analysis plan (SAP). The source and quality of the data, along with any potential problems affecting its applicability or limitations, will be documented. Supporting documentation will be used to evaluate the quality and usefulness of the data. If supporting documentation does not accompany the data, a records or file search will be conducted to obtain the supporting documentation.

When historical sampling data will be used, the data should be reviewed to determine the quality assurance and quality control procedures that were implemented when the data were collected (for example, were the data collected under an EPA-approved quality assurance project plan?). If this information is not available, the use of the data may be limited. Generally, data that is not supported by documented and acceptable quality procedures cannot be used for enforcement purposes but may be useful for preliminary analysis and assessment. Evaluation and verification procedures for secondary data should be approved by the Tetra Tech's QA officer.

When a large external data set is used, computer-assisted data screening may be applied to determine the internal consistency of the data set. The goal of such screening is to identify outliers from the overall data set. When data accuracy is primarily an issue of transcription accuracy, such as keying large data sets into a computer file, proof readers will independently check the transcribed data.

QAPP WORKSHEET #14
SUMMARY OF PROJECT TASKS

Sampling Tasks:
Sampling activities for each project will be outlined in a site-specific sampling and analysis plan (SAP). The SAP will summarize the sample network design and rationale, including: the numbers and types of samples to be collected, sampling locations, sampling frequencies, sample matrices, and measurement parameters. Sampling procedures will vary with each project and will be specified in the site-specific SAP. Worksheet #21 lists the standard operating procedures (SOP) that Tetra Tech will use to guide sampling activities. Worksheet #19 includes requirements for containers, volumes, preservation methods, and holding times for samples that might be commonly required under the START contract. Requirements for collecting QC samples are included in Worksheet #20.
Analysis Tasks:
The source of analytical services to be provided will be determined by data quality objectives (DQO), the intended use of the resulting data, and technical direction document (TDD) requirements and constraints, such as quick turnaround of data. Tetra Tech may obtain analytical services from the EPA Region 5 Central Regional Laboratory (CRL) or through EPA Contract Laboratory Program (CLP) laboratories. However, if the EPA laboratories are at capacity, unable to implement a specific analytical method, or unable to achieve quantitation limits required by DQOs, the required analytical services will be provided by subcontracted laboratories procured by Tetra Tech. The site-specific SAP will identify the specific laboratory that has been selected to provide analytical services. Worksheets #23 and 30 include additional information about the analytical methods and services that will be required under the START contract.
QC Tasks:
Field and laboratory quality control (QC) samples and measurements will be used to verify that analytical data meet project-specific quality objectives. Field QC samples and measurements will be used to assess how the sampling activities and measurements influence data quality. Requirements for collecting field QC samples are outlined in Worksheet #20. Similarly, laboratory QC samples will be used to assess how a laboratory's analytical program influences data quality. The site-specific SAP will describe (usually in table format) the QC samples to be analyzed during the investigation for each field and laboratory environmental measurement method and each sample matrix type. Worksheets #12 and 28 summarize the QC samples and acceptance criteria for analytical methods that will be used for most samples collected under the START contract.
Secondary Data:
Some work under the START contract may rely on secondary data from other sources such as reports, databases, spreadsheets, and literature files. When secondary data is of critical importance in supporting sampling and analytical measurements, quality requirements will be outlined in the site-specific sampling and analysis plan (SAP). Secondary data requirements are addressed Worksheet #13.
Data Management Tasks:
Tetra Tech project managers have the primary responsibility for defining project-specific data reporting requirements and for managing data under the START contract. Further details and requirements will be provided as necessary in site-specific SAPs, including requirements for data recording, validation, transformation, transmittal, reduction, analysis, tracking, storage, and retrieval. Data management requirements and tasks are addressed in Worksheet #29.
Documentation and Records:
Data for the START contract will be obtained from a combination of sources, including field measurements and laboratory analyses. The process of data gathering is a coordinated effort and will be conducted by project staff in conjunction with data producers. Worksheet #27 includes additional information about how Tetra Tech will document field activities, and Worksheet #29 summarizes general requirements for managing data under the START contract. Further detail and requirements will be provided as necessary in site-specific SAPs.

QAPP WORKSHEET #14 (CONTINUED)
SUMMARY OF PROJECT TASKS

Assessment/Audit Tasks:
Under the START contract, Tetra Tech may conduct performance and system audits of both field and laboratory activities to verify that sampling and analysis are performed in accordance with the procedures and requirements established in this QAPP and in site-specific SAPs. Worksheets #31 and 32 include additional information about these assessments and resulting corrective actions. If project-specific audits are planned for or required by a TDD, they will be identified in the site-specific SAP.
Data Review Tasks:
Data reduction, review, and verification are essential functions for preparing data that can be effectively used to support project decisions and DQOs. Data review and verification includes procedures conducted by field or laboratory personnel to ensure that measurement results are correct and acceptable relative to QA objectives in this QAPP and in any site-specific SAP. Field and laboratory measurement data reduction, review, and verification procedures and requirements are specified in field and laboratory methods, SOPs, and guidance documents. In most cases, data review, reduction, and verification procedures can be identified in site-specific SAP by referencing these sources. However, if data review, reduction, and verification are not adequately described in these sources, the site-specific SAP will include additional information. Worksheet #34 includes additional discussion of data review tasks and requirements.

QAPP WORKSHEET #15
REFERENCE LIMITS AND EVALUATION

VOCs in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	Trace Level	Low Level
Dichlorodifluoromethane	75-71-8	200	NC	590	0.5	5.0
Chloromethane	74-87-3	190	NC	560	0.5	5.0
Vinyl chloride	75-01-4	0.019	2.0	1.9	0.5	5.0
Bromomethane	74-83-9	7.5	NC	23	0.5	5.0
Chloroethane	75-00-3	21,000	NC	63,000	0.5	5.0
Trichlorofluoromethane	75-69-4	5,200	NC	15,000	0.5	5.0
1,1-Dichloroethene	75-35-4	280	7.0	850	0.5	5.0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	55,000	NC	170,000	0.5	5.0
Acetone	67-64-1	14,000	NC	42,000	5.0	10.0
Carbon disulfide	75-15-0	810	NC	2,400	0.5	5.0
Methyl acetate	79-20-9	20,000	NC	60,000	0.5	5.0
Methylene chloride	75-09-2	11	5.0	320	0.5	5.0
trans-1,2-Dichloroethene	156-60-5	360	100	1,100	0.5	5.0
Methyl tert-butyl ether	1634-04-4	14	NC	1,400	0.5	5.0
1,1-Dichloroethane	75-34-3	2.8	NC	280	0.5	5.0
cis-1,2-Dichloroethene	156-59-2	36	70.0	110	0.5	5.0
2-Butanone	78-93-3	5,600	NC	17,000	5.0	10.0
Bromochloromethane	74-97-5	83	NC	250	0.5	5.0
Chloroform	67-66-3	0.22	NC	22	0.5	5.0
1,1,1-Trichloroethane	71-55-6	8,000	200	24,000	0.5	5.0
Cyclohexane	110-82-7	13,000	NC	38,000	0.5	5.0
Carbon tetrachloride	56-23-5	0.46	5.0	46	0.5	5.0
Benzene	71-43-2	0.46	5.0	46	0.5	5.0
1,2-Dichloroethane	107-06-2	0.17	5.0	17	0.5	5.0

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	Trace Level	Low Level
Trichloroethene	79-01-6	0.49	5.0	8.5	0.5	5.0
Methylcyclohexane	108-87-2	NC	NC	NC	0.5	5.0
1,2-Dichloropropane	78-87-5	0.44	5.0	25	0.5	5.0
Bromodichloromethane	75-27-4	0.13	NC	13	0.5	5.0
cis-1,3-Dichloropropene	10061-01-5	NC	NC	NC	0.5	5.0
4-Methyl-2-pentanone	108-10-1	6,300	NC	19,000	5.0	10.0
Toluene	108-88-3	1,100	1,000	3,300	0.5	5.0
trans-1,3-Dichloropropene	10061-02-6	NC	NC	NC	0.5	5.0
1,1,2-Trichloroethane	79-00-5	0.28	5.0	1.2	0.5	5.0
Tetrachloroethene	127-18-4	11	5.0	120	0.5	5.0
2-Hexanone	591-78-6	38	NC	110	5.0	10.0
Dibromochloromethane	124-48-1	0.87	NC	87	0.5	5.0
1,2-Dibromoethane	106-93-4	0.0075	0.05	0.75	0.5	5.0
Chlorobenzene	108-90-7	78	100	230	0.5	5.0
Ethylbenzene	100-41-4	1.5	700	150	0.5	5.0
o-Xylene	95-47-6	190	10,000	580	0.5	5.0
m,p-Xylene	179601-23-1	190	10,000	580	0.5	5.0
Styrene	100-42-5	1,200	100	3,600	0.5	5.0
Bromoform	75-25-2	3.3	NC	330	0.5	5.0
Isopropylbenzene (cumene)	98-82-8	450	NC	1,400	0.5	5.0
1,1,2,2-Tetrachloroethane	79-34-5	0.076	NC	7.6	0.5	5.0
1,3-Dichlorobenzene	541-73-1	NC	NC	NC	0.5	5.0
1,4-Dichlorobenzene	106-46-7	0.48	75	48	0.5	5.0
1,2-Dichlorobenzene	95-50-1	300	600	910	0.5	5.0
1,2-Dibromo-3-chloropropane[f]	96-12-8	0.00033	0.2	0.033	0.5	5.0
1,2,4-Trichlorobenzene	120-82-1	1.2	70	12	0.5	5.0
1,2,3-Trichlorobenzene	87-61-6	7.0	NC	21	0.5	5.0

VOCs in Soil, Sediment, and Waste

Analyte Name	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]	
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	Low Level	Medium Level
Dichlorodifluoromethane	75-71-8	87	370	260	1,100	0.005	0.250
Chloromethane	74-87-3	110	460	330	1,400	0.005	0.250
Vinyl chloride	75-01-4	0.059	1.7	5.9	170	0.005	0.250
Bromomethane	74-83-9	6.8	30	21	90	0.005	0.250
Chloroethane	75-00-3	14,000	57,000	41,000	170,000	0.005	0.250
Trichlorofluoromethane	75-69-4	23,000	350,000	70,000	1,100,000	0.005	0.250
1,1-Dichloroethene	75-35-4	230	1,000	680	3,000	0.005	0.250
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	40,000	170,000	120,000	500,000	0.005	0.250
Acetone	67-64-1	61,000	670,000	180,000	2,000,000	0.010	0.500
Carbon disulfide	75-15-0	770	3,500	2,300	10,000	0.005	0.250
Methyl acetate	79-20-9	78,000	1,200,000	230,000	3,500,000	0.005	0.250
Methylene chloride	75-09-2	57	1,000	1,000	9,500	0.005	0.250
trans-1,2-Dichloroethene	156-60-5	1,600	23,000	4,700	70,000	0.005	0.250
Methyl tert-butyl ether	1634-04-4	47	210	4,700	21,000	0.005	0.250
1,1-Dichloroethane	75-34-3	3.6	16	360	1,600	0.005	0.250
cis-1,2-Dichloroethene	156-59-2	160	2,300	470	7,000	0.005	0.250
2-Butanone	78-93-3	27,000	190,000	81,000	580,000	0.010	0.500
Bromochloromethane	74-97-5	150	630	450	1,900	0.005	0.250
Chloroform	67-66-3	0.32	1.4	32	140	0.005	0.250
1,1,1-Trichloroethane	71-55-6	8,100	36,000	24,000	110,000	0.005	0.250
Cyclohexane	110-82-7	6,500	27,000	20,000	82,000	0.005	0.250
Carbon tetrachloride	56-23-5	0.65	2.9	65	290	0.005	0.250
Benzene	71-43-2	1.2	5.1	120	510	0.005	0.250
1,2-Dichloroethane	107-06-2	0.46	2.0	46	200	0.005	0.250
Trichloroethene	79-01-6	0.94	6.0	12	56	0.005	0.250

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte Name	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]	
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	Low Level	Medium Level
Methylcyclohexane	108-87-2	NC	NC	NC	NC	0.005	0.250
1,2-Dichloropropane	78-87-5	1.0	4.4	47	200	0.005	0.250
Bromodichloromethane	75-27-4	0.29	1.3	29	130	0.005	0.250
cis-1,3-Dichloropropene	10061-01-5	NC	NC	NC	NC	0.005	0.250
4-Methyl-2-pentanone	108-10-1	33,000	140,000	99,000	420,000	0.010	0.500
Toluene	108-88-3	4,900	47,000	15,000	140,000	0.005	0.250
trans-1,3-Dichloropropene	10061-02-6	NC	NC	NC	NC	0.005	0.250
1,1,2-Trichloroethane	79-00-5	1.1	5.0	4.5	19	0.005	0.250
Tetrachloroethene	127-18-4	24	100	240	1,200	0.005	0.250
2-Hexanone	591-78-6	200	1,300	600	4,000	0.010	0.500
Dibromochloromethane	124-48-1	8.3	39	830	3,900	0.005	0.250
1,2-Dibromoethane	106-93-4	0.036	0.16	3.6	16	0.005	0.250
Chlorobenzene	108-90-7	280	1,300	830	4,000	0.005	0.250
Ethylbenzene	100-41-4	5.8	25	580	2,500	0.005	0.250
o-Xylene	95-47-6	650	2,800	1,900	8,400	0.005	0.250
m,p-Xylene	179601-23-1	550	2,400	1,700	7,200	0.005	0.250
Styrene	100-42-5	6,000	35,000	18,000	100,000	0.005	0.250
Bromoform	75-25-2	19	86	1,900	8,600	0.005	0.250
Isopropylbenzene (cumene)	98-82-8	1,900	9,900	5,800	30,000	0.005	0.250
1,1,2,2-Tetrachloroethane	79-34-5	0.60	2.7	60	270	0.005	0.250
1,3-Dichlorobenzene	541-73-1	NC	NC	NC	NC	0.005	0.250
1,4-Dichlorobenzene	106-46-7	2.6	11	260	1,100	0.005	0.250
1,2-Dichlorobenzene	95-50-1	1,800	9,300	5,400	28,000	0.005	0.250
1,2-Dibromo-3-chloropropane	96-12-8	0.0053	0.064	0.53	6.4	0.005	0.250
1,2,4-Trichlorobenzene	120-82-1	24	110	170	770	0.005	0.250
1,2,3-Trichlorobenzene	87-61-6	63	930	190	2,800	0.005	0.250

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

VOCs in Air and Soil Gas

Analyte	CAS Number	Possible Action Limit (µg/m³)[a]				Laboratory Reporting Limit (µg/m³)[b]	
		EPA RSL (Residential Air)[c]	EPA RSL (Industrial Air)[c]	EPA VISL (Indoor Air)[g]	EPA VISL (Sub-Slab Vapor)[g]	Scan	SIM
Propylene	115-07-1	3,100	13,000	9,400	310,000	0.86	NA
Dichlorodifluoromethane (Freon 12)	75-71-8	100	440	310	10,000	2.47	NA
Dichlorotetrafluoroethane (Freon 114)	76-14-2	NC	NC	NC	NC	3.50	NA
Chloromethane	74-87-3	94	390	280	9,400	1.03	NA
Vinyl chloride	75-01-4	0.17	2.8	17	560	1.28	0.128
1,3-Butadiene	106-99-0	0.094	0.41	6.3	210	1.11	NA
Bromomethane	74-83-9	5.2	22	16	520	1.94	NA
Chloroethane	75-00-3	10,000	44,000	31,000	1,000,000	1.32	NA
Ethanol	64-17-5	NC	NC	NC	NC	0.94	NA
Trichlorofluoromethane (Freon 11)	75-69-4	NC	NC	NC	NC	2.81	NA
1,1-Dichloroethene	75-35-4	210	880	630	21,000	1.98	0.198
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	31,000	130,000	94,000	3,100,000	3.83	NA
Acetone	67-64-1	32,000	140,000	97,000	3,200,000	1.19	NA
2-Propanol (Isopropanol)	67-63-0	210	880	630	21,000	1.23	NA
Carbon disulfide	75-15-0	730	3,100	2,200	73,000	1.56	NA
Methylene chloride	75-09-2	100	1,200	1,900	63,000	1.74	NA
trans-1,2-Dichloroethene	156-60-5	NC	NC	NC	NC	1.98	0.198
n-Hexane	110-54-3	730	3,100	2,200	73,000	1.76	NA
Methyl tert-butyl ether	1634-04-4	11	47	1,100	36,000	1.80	0.18
1,1-Dichloroethane	75-34-3	1.8	7.7	180	5,800	2.02	0.202
cis-1,2-Dichloroethene	156-59-2	NC	NC	NC	NC	1.98	0.198
2-Chloro-1,3-butadiene (Chloroprene)[h]	126-99-8	0.0094	0.041	0.94	31	1.81	NA
2-Butanone	78-93-3	5,200	22,000	16,000	520,000	1.47	NA
Tetrahydrofuran	109-99-9	2,100	8,800	6,300	210,000	1.47	NA

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (µg/m³)[a]				Laboratory Reporting Limit (µg/m³)[b]	
		EPA RSL (Residential Air)[c]	EPA RSL (Industrial Air)[c]	EPA VISL (Indoor Air)[g]	EPA VISL (Sub-Slab Vapor)[g]	Scan	SIM
Chloroform	67-66-3	0.12	0.53	12	410	2.44	NA
1,1,1-Trichloroethane	71-55-6	5,200	22,000	16,000	520,000	2.73	0.273
Cyclohexane	110-82-7	6,300	26,000	19,000	630,000	1.72	NA
Carbon tetrachloride	56-23-5	0.47	2.0	47	1,600	3.15	NA
Ethyl Acetate	141-78-6	73	310	220	7,300	1.80	NA
Vinyl Acetate	108-05-4	210	880	630	21,000	1.76	NA
Benzene	71-43-2	0.36	1.6	36	1,200	1.60	0.16
1,2-Dichloroethane	107-06-2	0.11	0.47	11	360	2.02	0.202
n-Heptane	142-82-5	NC	NC	NC	NC	2.05	NA
1,4-Dioxane	123-91-1	0.56	2.5	56	1,900	1.80	NA
Trichloroethene	79-01-6	0.48	3.0	6.3	210	2.69	0.269
1,2-Dichloropropane	78-87-5	0.28	1.2	13	420	2.31	NA
Bromodichloromethane	75-27-4	0.076	0.33	7.6	250	3.35	NA
cis-1,3-Dichloropropene	10061-01-5	NC	NC	NC	NC	2.27	NA
4-Methyl-2-pentanone	108-10-1	3,100	13,000	9,400	310,000	2.05	NA
Toluene	108-88-3	5,200	22,000	16,000	520,000	1.88	0.188
trans-1,3-Dichloropropene	10061-02-6	NC	NC	NC	NC	2.27	NA
1,1,2-Trichloroethane	79-00-5	0.18	0.77	0.63	21	2.73	0.273
Tetrachloroethene	127-18-4	11	47	130	4,200	3.39	0.339
2-Hexanone	591-78-6	31	130	94	3,100	2.05	NA
Dibromochloromethane	124-48-1	NC	NC	NC	NC	4.26	NA
1,2-Dibromoethane	106-93-4	0.0047	0.020	0.47	16	3.84	0.15[i]
n-Octane	111-65-9	NC	NC	NC	NC	2.34	NA
Chlorobenzene	108-90-7	52	220	160	5,200	2.30	NA
Ethylbenzene	100-41-4	1.1	4.9	110	3,700	2.17	0.217
o-Xylene	95-47-6	100	440	310	10,000	2.17	0.217

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (µg/m³)[a]				Laboratory Reporting Limit (µg/m³)[b]	
		EPA RSL (Residential Air)[c]	EPA RSL (Industrial Air)[c]	EPA VISL (Indoor Air)[g]	EPA VISL (Sub-Slab Vapor)[g]	Scan	SIM
m,p-Xylene	179601-23-1	100	440	310	10,000	2.17	0.217
Styrene	100-42-5	1,000	4,400	3,100	100,000	2.13	NA
Bromoform	75-25-2	2.6	11	260	8,500	5.17	NA
Cumene	98-82-8	420	1,800	1,300	42,000	2.46	NA
1,1,2,2-Tetrachloroethane	79-34-5	0.048	0.21	4.8	160	3.43	0.343
Propylbenzene	103-65-1	1,000	4,400	3,100	100,000	2.46	NA
4-Ethyltoluene	622-96-8	NC	NC	NC	NC	2.46	NA
1,3,5-Trimethylbenzene	108-67-8	NC	NC	NC	NC	2.46	NA
1,2,4-Trimethylbenzene	95-63-6	7.3	31	22	730	2.46	NA
Benzyl Chloride	100-44-7	0.057	0.25	3.1	100	2.59	NA
1,3-Dichlorobenzene	541-73-1	NC	NC	NC	NC	3.01	NA
1,4-Dichlorobenzene	106-46-7	0.26	1.1	26	850	3.01	NA
1,2-Dichlorobenzene	95-50-1	210	880	630	21,000	3.01	NA
Hexachlorobutadiene	87-68-3	0.13	0.56	13	430	5.33	NA
1,2,4-Trichlorobenzene	120-82-1	2.1	8.8	6.3	210	3.71	NA

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

SVOCs in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	SIM	Low Level
1,4-Dioxane	123-91-1	0.46	NC	46	NA	2
Benzaldehyde	100-52-7	19	NC	1,900	NA	10
Phenol	108-95-2	5,800	NC	17,000	NA	10
Bis(2-chloroethyl) ether	111-44-4	0.014	NC	1.4	NA	1[j]
2-Chlorophenol	95-57-8	91	NC	270	NA	5
2-Methylphenol	95-48-7	930	NC	2,800	NA	10
3-Methylphenol	108-39-4	930	NC	2,800	NA	5
2,2'-Oxybis(1-chloropropane)	108-60-1	710	NC	2,100	NA	10
Acetophenone	98-86-2	1,900	NC	5,800	NA	10
4-Methylphenol	106-44-5	1,900	NC	5,600	NA	10
N-Nitroso-di-n propylamine	621-64-7	0.011	NC	1.1	NA	1[j]
Hexachloroethane	67-72-1	0.33	NC	19	NA	5
Nitrobenzene	98-95-3	0.14	NC	14	NA	5
Isophorone	78-59-1	78	NC	7,800	NA	5
2-Nitrophenol	88-75-5	NC	NC	NC	NA	5
2,4-Dimethylphenol	105-67-9	360	NC	1,100	NA	5
Bis(2-chloroethoxy)methane	111-91-1	59	NC	180	NA	5
2,4-Dichlorophenol	120-83-2	46	NC	140	NA	5
Naphthalene	91-20-3	0.17	NC	17	0.1	5
4-Chloroaniline	106-47-8	0.37	NC	37	NA	10
Hexachlorobutadiene	87-68-3	0.14	NC	14	NA	5
Caprolactam	105-60-2	9,900	NC	30,000	NA	10
4-Chloro-3-methylphenol	59-50-7	1,400	NC	4,300	NA	5
2-Methylnaphthalene	91-57-6	36	NC	110	0.1	5
Hexachlorocyclopentadiene[k]	77-47-4	0.41	50	1.2	NA	5
2,4,6-Trichlorophenol	88-06-2	4.1	NC	36	NA	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	SIM	Low Level
2,4,5-Trichlorophenol	95-95-4	1,200	NC	3,500	NA	5
1,1'-Biphenyl	92-52-4	0.83	NC	2.5	NA	1[j]
2-Chloronaphthalene	91-58-7	750	NC	2,200	NA	5
2-Nitroaniline	88-74-4	190	NC	570	NA	5
Dimethylphthalate	131-11-3	NC	NC	NC	NA	5
2,6-Dinitrotoluene	606-20-2	0.049	NC	4.9	NA	1[j]
Acenaphthylene	208-96-8	NC	NC	NC	0.1	5
3-Nitroaniline	99-09-2	NC	NC	NC	NA	10
Acenaphthene	83-32-9	530	NC	1,600	0.1	5
2,4-Dinitrophenol	51-28-5	39	NC	120	NA	10
4-Nitrophenol	100-02-7	NC	NC	NC	NA	10
Dibenzofuran	132-64-9	7.9	NC	24	NA	5
2,4-Dinitrotoluene	121-14-2	0.24	NC	24	NA	5
Diethylphthalate	84-66-2	15,000	NC	45,000	NA	5
Fluorene	86-73-7	290	NC	880	0.1	5
4-Chlorophenyl-phenyl ether	7005-72-3	NC	NC	NC	NA	5
4-Nitroaniline	100-01-6	3.8	NC	230	NA	10
4,6-Dinitro-2-methylphenol[k]	534-52-1	1.5	NC	4.5	NA	10
N-Nitrosodiphenylamine	86-30-6	12	NC	1,200	NA	5
1,2,4,5-Tetrachlorobenzene	95-94-3	1.7	NC	5.1	NA	5
4-Bromophenyl-phenylether	101-55-3	NC	NC	NC	NA	5
Hexachlorobenzene[k]	118-74-1	0.0098	1.0	0.98	NA	5
Atrazine	1912-24-9	0.30	3.0	30	NA	10
Pentachlorophenol	87-86-5	0.041	1.0	4.1	0.2	10
Phenanthrene	85-01-8	NC	NC	NC	0.1	5
Anthracene	120-12-7	1,800	NC	5,300	0.1	5
Carbazole	86-74-8	NC	NC	NC	NA	10
Di-n-butylphthalate	84-74-2	900	NC	2,700	NA	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	SIM	Low Level
Fluoranthene	206-44-0	800	NC	2,400	0.1	10
Pyrene	129-00-0	120	NC	360	0.1	5
Butylbenzylphthalate	85-68-7	16	NC	1,600	NA	5
3,3'-Dichlorobenzidine	91-94-1	0.13	NC	13	NA	10
Benzo(a)anthracene	56-55-3	0.012	NC	1.2	0.1	5
Chrysene	218-01-9	3.4	NC	340	0.1	5
Bis(2-ethylhexyl)phthalate	117-81-7	5.6	6.0	560	NA	5
Di-n-octylphthalate	117-84-0	200	NC	600	NA	10
Benzo(b)fluoranthene	205-99-2	0.034	NC	3.4	0.1	5
Benzo(k)fluoranthene	207-08-9	0.34	NC	34	0.1	5
Benzo(a)pyrene	50-32-8	0.0034	0.2	0.34	0.1	5
Indeno(1,2,3-cd)pyrene	193-39-5	0.034	NC	3.4	0.1	5
Dibenzo(a,h)anthracene	53-70-3	0.0034	NC	0.34	0.1	5
Benzo(g,h,i)perylene	191-24-2	NC	NC	NC	0.1	5
2,3,4,6-Tetrachlorophenol	58-90-2	240	NC	710	NA	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

SVOCs in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]		
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	SIM	Low Level	Medium Level
1,4-Dioxane	123-91-1	5.3	24	530	2,400	NA	0.067	2
Benzaldehyde	100-52-7	170	820	17,000	82,000	NA	0.330	10
Phenol	108-95-2	19,000	250,000	57,000	740,000	NA	0.330	10
Bis(2-chloroethyl) ether	111-44-4	0.23	1.0	23	100	NA	0.330	10
2-Chlorophenol	95-57-8	390	5,800	1,200	18,000	NA	0.170	5
2-Methylphenol	95-48-7	3,200	41,000	9,500	120,000	NA	0.330	10
2,2'-Oxybis(1-chloropropane)	108-60-1	3,100	47,000	9,400	140,000	NA	0.330	10
Acetophenone	98-86-2	7,800	120,000	23,000	350,000	NA	0.330	10
4-Methylphenol	106-44-5	6,300	82,000	19,000	250,000	NA	0.330	10
N-Nitroso-di-n propylamine	621-64-7	0.078	0.33	7.8	33	NA	0.170	5
Hexachloroethane	67-72-1	1.8	8.0	130	800	NA	0.170	5
Nitrobenzene	98-95-3	5.1	22	380	2,200	NA	0.170	5
Isophorone	78-59-1	570	2,400	38,000	240,000	NA	0.170	5
2-Nitrophenol	88-75-5	NC	NC	NC	NC	NA	0.170	5
2,4-Dimethylphenol	105-67-9	1,300	16,000	3,800	49,000	NA	0.170	5
Bis(2-chloroethoxy)methane	111-91-1	190	2,500	570	7,400	NA	0.170	5
2,4-Dichlorophenol	120-83-2	190	2,500	570	7,400	NA	0.170	5
Naphthalene	91-20-3	3.8	17	380	1,700	0.0033	0.170	5
4-Chloroaniline	106-47-8	2.7	11	270	1,100	NA	0.330	10
Hexachlorobutadiene	87-68-3	1.2	5.3	120	530	NA	0.170	5
Caprolactam	105-60-2	31,000	400,000	94,000	1,200,000	NA	0.330	10
4-Chloro-3-methylphenol	59-50-7	6,300	82,000	19,000	250,000	NA	0.170	5
2-Methylnaphthalene	91-57-6	240	3,000	720	9,000	0.0033	0.170	5
Hexachlorocyclopentadiene	77-47-4	1.8	7.5	5.3	22	NA	0.330	10
2,4,6-Trichlorophenol	88-06-2	49	210	190	2,500	NA	0.170	5
2,4,5-Trichlorophenol	95-95-4	6,300	82,000	19,000	250,000	NA	0.170	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]		
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	SIM	Low Level	Medium Level
1,1'-Biphenyl	92-52-4	47	200	140	600	NA	0.170	5
2-Chloronaphthalene	91-58-7	4,800	60,000	14,000	180,000	NA	0.170	5
2-Nitroaniline	88-74-4	630	8,000	1,900	24,000	NA	0.170	5
Dimethylphthalate	131-11-3	NC	NC	NC	NC	NA	0.170	5
2,6-Dinitrotoluene	606-20-2	0.36	1.5	36	150	NA	0.170	5
Acenaphthylene	208-96-8	NC	NC	NC	NC	0.0033	0.170	5
3-Nitroaniline	99-09-2	NC	NC	NC	NC	NA	0.330	10
Acenaphthene	83-32-9	3,600	45,000	11,000	140,000	0.0033	0.170	5
2,4-Dinitrophenol	51-28-5	130	1,600	380	4,900	NA	0.330	10
4-Nitrophenol	100-02-7	NC	NC	NC	NC	NA	0.330	10
Dibenzofuran	132-64-9	73	1,000	220	3,100	NA	0.170	5
2,4-Dinitrotoluene	121-14-2	1.7	7.4	170	740	NA	0.170	5
Diethylphthalate	84-66-2	51,000	660,000	150,000	2,000,000	NA	0.170	5
Fluorene	86-73-7	2,400	30,000	7,200	90,000	0.0033	0.170	5
4-Chlorophenyl-phenyl ether	7005-72-3	NC	NC	NC	NC	NA	0.170	5
4-Nitroaniline	100-01-6	27	110	760	9,800	NA	0.330	10
4,6-Dinitro-2-methylphenol	534-52-1	5.1	66	15	200	NA	0.330	10
N-Nitrosodiphenylamine	86-30-6	110	470	11,000	47,000	NA	0.170	5
1,2,4,5-Tetrachlorobenzene	95-94-3	23	350	70	1,100	NA	0.170	5
4-Bromophenyl-phenylether	101-55-3	NC	NC	NC	NC	NA	0.170	5
Hexachlorobenzene	118-74-1	0.21	0.96	21	96	NA	0.170	5
Atrazine	1912-24-9	2.4	10	240	1,000	NA	0.330	10
Pentachlorophenol	87-86-5	1.0	4.0	100	400	0.0067	0.330	10
Phenanthrene	85-01-8	NC	NC	NC	NC	0.0033	0.170	5
Anthracene	120-12-7	18,000	230,000	54,000	680,000	0.0033	0.170	5
Carbazole	86-74-8	NC	NC	NC	NC	NA	0.330	10
Di-n-butylphthalate	84-74-2	6,300	82,000	19,000	250,000	NA	0.170	5
Fluoranthene	206-44-0	2,400	30,000	7,200	90,000	0.0033	0.330	10

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Analyte	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]		
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	SIM	Low Level	Medium Level
Pyrene	129-00-0	1,800	23,000	5,400	68,000	0.0033	0.170	5
Butylbenzylphthalate	85-68-7	290	1,200	29,000	120,000	NA	0.170	5
3,3'-Dichlorobenzidine	91-94-1	1.2	5.1	120	510	NA	0.330	10
Benzo(a)anthracene	56-55-3	0.16	2.9	16	290	0.0033	0.170	5
Chrysene	218-01-9	16	290	1,600	29,000	0.0033	0.170	5
Bis(2-ethylhexyl)phthalate	117-81-7	39	160	3,800	16,000	NA	0.170	5
Di-n-octylphthalate	117-84-0	630	8,200	1,900	25,000	NA	0.330	10
Benzo(b)fluoranthene	205-99-2	0.16	2.9	16	290	0.0033	0.170	5
Benzo(k)fluoranthene	207-08-9	1.6	29	160	2,900	0.0033	0.170	5
Benzo(a)pyrene	50-32-8	0.016	0.29	1.6	29	0.0033	0.170	5
Indeno(1,2,3-cd)pyrene	193-39-5	0.16	2.9	16	290	0.0033	0.170	5
Dibenzo(a,h)anthracene	53-70-3	0.016	0.29	1.6	29	0.0033	0.170	5
Benzo(g,h,i)perylene	191-24-2	NC	NC	NC	NC	0.0033	0.170	5
2,3,4,6-Tetrachlorophenol	58-90-2	1,900	25,000	5,700	74,000	NA	0.170	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

PCBs in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	
Aroclor-1016	12674-11-2	0.22	0.5	4.2	1.0
Aroclor-1221	11104-28-2	0.0047	0.5	0.47	0.4[j]
Aroclor-1232	11141-16-5	0.0047	0.5	0.47	0.4[j]
Aroclor-1242	53469-21-9	0.0078	0.5	0.78	0.4[j]
Aroclor-1248	12672-29-6	0.0078	0.5	0.78	0.4[j]
Aroclor-1254	11097-69-1	0.0078	0.5	0.78	0.4[j]
Aroclor-1260	11096-82-5	0.0078	0.5	0.78	0.2[j]
Aroclor-1262	37324-23-5	NC	0.5	NC	1.0
Aroclor-1268	11100-14-4	NC	0.5	NC	1.0

PCBs in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (µg/kg)[a]				Laboratory Reporting Limit (µg/kg)[b]
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	
Aroclor-1016	12674-11-2	4,100	27,000	12,000	150,000	33
Aroclor-1221	11104-28-2	200	830	20,000	83,000	33
Aroclor-1232	11141-16-5	170	720	17,000	72,000	33
Aroclor-1242	53469-21-9	230	950	23,000	95,000	33
Aroclor-1248	12672-29-6	230	950	23,000	95,000	33
Aroclor-1254	11097-69-1	240	970	3,500	44,000	33
Aroclor-1260	11096-82-5	240	990	24,000	99,000	33
Aroclor-1262	37324-23-5	NC	NC	NC	NC	33
Aroclor-1268	11100-14-4	NC	NC	NC	NC	33

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Pesticides in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	
alpha-BHC	319-84-6	0.0072	NC	0.72	0.05
beta-BHC	319-85-7	0.025	NC	2.5	0.05
delta-BHC	319-86-8	NC	NC	NC	0.05
gamma-BHC (Lindane)	58-89-9	0.042	0.2	4.2	0.05
Heptachlor	76-44-8	0.0014	0.4	0.14	0.05
Aldrin	309-00-2	0.00092	NC	0.092	0.05
Heptachlor epoxide	1024-57-3	0.0014	0.2	0.14	0.05
Endosulfan I	959-98-8	NC	NC	NC	0.05
Dieldrin	60-57-1	0.0018	NC	0.18	0.1
4,4'-DDE	72-55-9	0.046	NC	4.6	0.1
Endrin	72-20-8	2.3	2.0	6.9	0.1
Endosulfan II	33213-65-9	NC	NC	NC	0.1
4,4'-DDD	72-54-8	0.032	NC	3.2	0.1
Endosulfan sulfate	1031-07-8	NC	NC	NC	0.1
4,4'-DDT	50-29-3	0.023	NC	23	0.1
Methoxychlor	72-43-5	37	40	110	0.5
Endrin ketone	53494-70-5	NC	NC	NC	0.1
Endrin aldehyde	7421-93-4	NC	NC	NC	0.1
cis-Chlordane	5103-71-9	0.02	2.0	2.0	0.05
trans-Chlordane	5103-74-2	0.02	2.0	2.0	0.05
Toxaphene	8001-35-2	0.071	3.0	7.1	5

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Pesticides in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	
alpha-BHC	319-84-6	0.086	0.36	8.6	36	0.0017
beta-BHC	319-85-7	0.30	1.3	30	130	0.0017
delta-BHC	319-86-8	NC	NC	NC	NC	0.0017
gamma-BHC (Lindane)	58-89-9	0.57	2.5	57	250	0.0017
Heptachlor	76-44-8	0.13	0.63	13	63	0.0017
Aldrin	309-00-2	0.039	0.18	3.9	18	0.0017
Heptachlor epoxide	1024-57-3	0.070	0.33	3.1	33	0.0017
Endosulfan I	959-98-8	NC	NC	NC	NC	0.0017
Dieldrin	60-57-1	0.034	0.14	3.4	14	0.0033
4,4'-DDE	72-55-9	2.0	9.3	200	930	0.0033
Endrin	72-20-8	19	250	57	740	0.0033
Endosulfan II	33213-65-9	NC	NC	NC	NC	0.0033
4,4'-DDD	72-54-8	2.3	9.6	230	960	0.0033
Endosulfan sulfate	1031-07-8	NC	NC	NC	NC	0.0033
4,4'-DDT	50-29-3	1.9	8.5	110	850	0.0033
Methoxychlor	72-43-5	320	4,100	950	12,000	0.017
Endrin ketone	53494-70-5	NC	NC	NC	NC	0.0033
Endrin aldehyde	7421-93-4	NC	NC	NC	NC	0.0033
cis-Chlordane	5103-71-9	1.7	7.7	100	770	0.0017
trans-Chlordane	5103-74-2	1.7	7.7	100	770	0.0017
Toxaphene	8001-35-2	0.49	2.1	49	210	0.170

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Herbicides in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[l]
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	
2,4-D	94-75-7	170	70	520	0.20
2,4-DB	94-82-6	120	NC	360	0.80
2,4,5-TP (Silvex)	93-72-1	110	50	330	0.075
2,4,5-T	93-76-5	160	NC	490	0.080
Dalapon	75-99-0	600	200	1,800	1.3
Dicamba	1918-00-9	570	NC	1,700	0.081
Dichloroprop	120-36-5	NC	NC	NC	0.26
Dinoseb	88-85-7	15	7.0	44	0.19
MCPA	94-74-6	7.5	NC	23	0.056
MCPP	93-65-2	16	NC	47	0.090
4-Nitrophenol	100-02-1	NC	NC	NC	0.13
Pentachlorophenol	87-86-5	0.041	1.0	4.1	0.076

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Herbicides in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (µg/kg)[a]				Laboratory Reporting Limit (µg/kg)[l]
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	
2,4-D	94-75-7	700,000	9,600,000	2,100,000	29,000,000	0.11
2,4-DB	94-82-6	510,000	6,600,000	1,500,000	20,000,000	NL
2,4,5-TP (Silvex)	93-72-1	510,000	6,600,000	1,500,000	20,000,000	0.28
2,4,5-T	93-76-5	630,000	8,200,000	1,900,000	25,000,000	NL
Dalapon	75-99-0	1,900,000	25,000,000	5,700,000	74,000,000	0.12
Dicamba	1918-00-9	1,900,000	25,000,000	5,700,000	74,000,000	NL
Dichloroprop	120-36-5	NC	NC	NC	NC	NL
Dinoseb	88-85-7	63,000	820,000	190,000	2,500,000	NL
MCPA	94-74-6	32,000	410,000	95,000	1,200,000	43
MCPP	93-65-2	63,000	820,000	190,000	2,500,000	66
4-Nitrophenol	100-02-1	NC	NC	NC	NC	0.34
Pentachlorophenol	87-86-5	1,000	4,000	100,000	400,000	0.16

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Dioxins and Furans in Water

Analyte	CAS Number	Possible Action Limit (pg/L)[a]			Laboratory Reporting Limit (pg/L)[b]
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	
2,3,7,8-TCDD	1746-01-6	0.12	30	12	10
1,2,3,7,8-PeCDD	40321-76-4	NC	NC	NC	50
1,2,3,6,7,8-HxCDD	57653-85-7	NC	NC	NC	50
1,2,3,4,7,8-HxCDD	39227-28-6	NC	NC	NC	50
1,2,3,7,8,9-HxCDD	19408-74-3	NC	NC	NC	50
1,2,3,4,6,7,8-HpCDD	35822-46-9	NC	NC	NC	50
OCDD	3268-87-9	NC	NC	NC	100
2,3,7,8-TCDF	51207-31-9	NC	NC	NC	10
1,2,3,7,8-PeCDF	57117-41-6	NC	NC	NC	50
2,3,4,7,8-PeCDF	57117-31-4	NC	NC	NC	50
1,2,3,6,7,8-HxCDF	57117-44-9	NC	NC	NC	50
1,2,3,7,8,9-HxCDF	72918-21-9	NC	NC	NC	50
1,2,3,4,7,8-HxCDF	70648-26-9	NC	NC	NC	50
2,3,4,6,7,8-HxCDF	60851-34-5	NC	NC	NC	50
1,2,3,4,6,7,8-HpCDF	67562-39-4	NC	NC	NC	50
1,2,3,4,7,8,9-HpCDF	55673-89-7	NC	NC	NC	50
OCDF	39001-02-0	NC	NC	NC	100

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Dioxins and Furans in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (ng/kg)[a]				Laboratory Reporting Limit (ng/kg)[b]
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	
2,3,7,8-TCDD	1746-01-6	4.8	22	150	2,200	1.0
1,2,3,7,8-PeCDD	40321-76-4	NC	NC	NC	NC	5.0
1,2,3,6,7,8-HxCDD	57653-85-7	NC	NC	NC	NC	5.0
1,2,3,4,7,8-HxCDD	39227-28-6	NC	NC	NC	NC	5.0
1,2,3,7,8,9-HxCDD	19408-74-3	NC	NC	NC	NC	5.0
1,2,3,4,6,7,8-HpCDD	35822-46-9	NC	NC	NC	NC	5.0
OCDD	3268-87-9	NC	NC	NC	NC	10
2,3,7,8-TCDF	51207-31-9	NC	NC	NC	NC	1.0
1,2,3,7,8-PeCDF	57117-41-6	NC	NC	NC	NC	5.0
2,3,4,7,8-PeCDF	57117-31-4	NC	NC	NC	NC	5.0
1,2,3,6,7,8-HxCDF	57117-44-9	NC	NC	NC	NC	5.0
1,2,3,7,8,9-HxCDF	72918-21-9	NC	NC	NC	NC	5.0
1,2,3,4,7,8-HxCDF	70648-26-9	NC	NC	NC	NC	5.0
2,3,4,6,7,8-HxCDF	60851-34-5	NC	NC	NC	NC	5.0
1,2,3,4,6,7,8-HpCDF	67562-39-4	NC	NC	NC	NC	5.0
1,2,3,4,7,8,9-HpCDF	55673-89-7	NC	NC	NC	NC	5.0
OCDF	39001-02-0	NC	NC	NC	NC	10

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Metals (including Cyanide) in Water

Analyte	CAS Number	Possible Action Limit (µg/L)[a]			Laboratory Reporting Limit (µg/L)[b]	
		EPA RSL (Tapwater)[c]	MCL[d]	EPA RML (Tapwater)[e]	ICP-AES	ICP-MS
Aluminum	7429-90-5	20,000	NC	60,000	200	20
Antimony	7440-36-0	7.8	6.0	23	60	2
Arsenic	7440-38-2	0.052	10	5.2	10	1
Barium	7440-39-3	3,800	2,000	11,000	200	10
Beryllium	7440-41-7	25	4.0	74	5	1
Cadmium	7440-43-9	9.2	5.0	28	5	1
Calcium	7440-70-2	NC	NC	NC	5,000	500
Chromium	7440-47-3	NC	100	NC	10	2
Cobalt	7440-48-4	6.0	NC	18	50	1
Copper	7440-50-8	800	1,300	2,400	25	2
Iron	7439-89-6	14,000	NC	42,000	100	200
Lead	7439-92-1	15	15	15	10	1
Magnesium	7439-95-4	NC	NC	NC	5,000	500
Manganese	7439-96-5	430	NC	1,300	15	1
Nickel	7440-02-0	390	NC	1,200	40	1
Potassium	7440-09-7	NC	NC	NC	5,000	500
Selenium	7782-49-2	100	50	300	35	5
Silver	7440-22-4	94	NC	280	10	1
Sodium	7440-23-5	NC	NC	NC	5,000	500
Thallium[k]	7440-28-0	0.20	2.0	0.60	25	1
Vanadium	7440-62-2	86	NC	260	50	5
Zinc	7440-66-6	6,000	NC	18,000	60	2
					Laboratory Reporting Limit (µg/L)[b]	
Mercury	7439-97-6	0.63	2.0	1.9	0.2	
Cyanide[k]	57-12-5	1.5	200	4.4	10	

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Metals (including Cyanide) in Soil, Sediment, and Waste

Analyte	CAS Number	Possible Action Limit (mg/kg)[a]				Laboratory Reporting Limit (mg/kg)[b]	
		EPA RSL (Residential Soil)[c]	EPA RSL (Industrial Soil)[c]	EPA RML (Residential Soil)[e]	EPA RML (Industrial Soil)[e]	ICP-AES	ICP-MS
Aluminum	7429-90-5	77,000	1,100,000	230,000	3,400,000	20	NA
Antimony	7440-36-0	31	470	94	1,400	6	1
Arsenic	7440-38-2	0.68	3.0	68	300	1	0.5
Barium	7440-39-3	15,000	220,000	46,000	650,000	20	5
Beryllium	7440-41-7	160	2,300	470	6,900	0.5	0.5
Cadmium	7440-43-9	71	980	210	2,900	0.5	0.5
Calcium	7440-70-2	NC	NC	NC	NC	500	NA
Chromium	7440-47-3	NC	NC	NC	NC	1	1
Cobalt	7440-48-4	23	350	70	1,000	5	0.5
Copper	7440-50-8	3,100	47,000	9,400	140,000	2.5	1
Iron	7439-89-6	55,000	820,000	160,000	2,500,000	10	NA
Lead	7439-92-1	400	800	400	800	1	0.5
Magnesium	7439-95-4	NC	NC	NC	NC	500	NA
Manganese	7439-96-5	1,800	26,000	5,500	77,000	1.5	0.5
Nickel	7440-02-0	1,500	22,000	4,600	67,000	4	0.5
Potassium	7440-09-7	NC	NC	NC	NC	500	NA
Selenium	7782-49-2	390	5,800	1,200	18,000	3.5	2.5
Silver	7440-22-4	390	5,800	1,200	18,000	1	0.5
Sodium	7440-23-5	NC	NC	NC	NC	500	NA
Thallium	7440-28-0	0.78	12	2.3	35	2.5	0.5
Vanadium	7440-62-2	390	5,800	1,200	17,000	5	2.5
Zinc	7440-66-6	23,000	350,000	70,000	1,100,000	6	1
						Laboratory Reporting Limit (mg/kg)[b]	
Mercury	7439-97-6	11	46	33	140	0.1	
Cyanide	57-12-5	23	150	69	440	0.5	

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

Notes:

a EPA removal management levels (RML) for water and soil and EPA vapor intrusion screening levels (VISL) for indoor air and sub-slab vapor will be used as the action limits for most sites.

b Laboratory reporting limits are from the EPA Contract Laboratory Program (CLP) Statements of Work unless otherwise noted. Reporting limits for subcontracted laboratories may be lower than the limits listed in this worksheet. CLP reporting limits are available at available under "Target Analytes" at the following locations:
http://www2.epa.gov/clp/organic-analytical-service-within-superfund-contract-laboratory-program
http://www2.epa.gov/clp/inorganic-analytical-service-within-superfund-contract-laboratory-program
http://www2.epa.gov/clp/dioxins-furans-pcbs-and-congeners-analytical-service-within-superfund-contract-laboratory
http://pubweb.epa.gov/superfund/programs/clp/sav1.htm

c EPA regional screening levels (RSL) (EPA 2016a) are available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016

d EPA maximum contaminant levels for drinking water are available at: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants

e EPA RMLs are based on a target risk of 1.0 E-04 for carcinogens and a target hazard quotient of 3 for non-carcinogens (EPA 2016b). RMLs are available at: http://www2.epa.gov/risk/regional-removal-management-levels-chemicals-rmls

f Reporting limits for subcontracted laboratories are likely to be higher than EPA Tapwater RSLs and RMLs for 1,2-dibromo-3-chloropropane.

g EPA VISLs are based on a target risk of 1.0 E-04 for carcinogens and a target hazard quotient of 3 for non-carcinogens (EPA 2015a). VISLs are available at: http://www2.epa.gov/vaporintrusion

h 2-Chloro-1,3-butadiene (chloroprene) is not reported as a target analyte by most laboratories that analyze volatile organic compounds (VOC) in air by EPA Method TO-15. If reported, laboratory reporting limits are likely to exceed EPA VISLs for air and soil gas.

i SIM reporting limit for 1,2-dibromoethane in air and is for Eurofins Air Toxics, Inc. Other subcontracted laboratories may also be able to achieve reporting limits below EPA VISLs.

j Reporting limit listed is for CT Laboratories LLC and is lower than the EPA Tapwater RML.

k CLP reporting limit is higher than EPA Tapwater RML, but subcontracted laboratories may be able to achieve lower limits. Further, subcontracted laboratories will report results below their reporting limits, but above method detection limits, as estimated. These estimated reported results may be below RMLs.

l Herbicide reporting limits are from SW-846 Method 8151A and are available at: https://www.epa.gov/hw-sw846/sw-846-test-method-8151a-chlorinated-herbicides-gas-chromatography-gc-using-methylation-or

µg/kg Microgram per kilogram
µg/L Microgram per liter
µg/m^3 Microgram per cubic meter
CAS Chemical Abstract Service
MCL Maximum contaminant level
mg/kg Milligram per kilogram
NA Not available
NC No criteria

QAPP WORKSHEET #15 (CONTINUED)
REFERENCE LIMITS AND EVALUATION

ng/kg	Nanogram per kilogram
NL	Not listed in SW-846 – check with laboratory for reporting limits
pg/L	Picogram per liter
RML	Removal management level
RSL	Regional screening level
SIM	Selected ion monitoring
VISL	Vapor intrusion screening level

Note: EPA RMLs and RSLs in this QAPP revision are from the May 2016 updates; VISLs are from the November 2015 update. Highlighted numbers have changed from previous values.

QAPP WORKSHEET #16
PROJECT SCHEDULE AND TIMELINE

Activity	Organization	Anticipated Start Date	Anticipated Completion Date	Deliverable	Deliverable Due Date
Prepare site-specific SAP	Tetra Tech	Before sampling	TBD	Site-specific SAP	TBD
Prepare HASP	Tetra Tech	Before sampling	TBD	HASP	TBD
Prepare analytical services request	Tetra Tech	Before sampling	TBD	Analytical services request	TBD
Procure field equipment	Tetra Tech	Before sampling	TBD	NA	NA
Complete field reconnaissance	Tetra Tech	Before sampling	TBD	NA	NA
Collect field samples	Tetra Tech	TBD	TBD	NA	NA
Analyze samples	Laboratory	TBD	TBD	Laboratory data package	TBD
Validate laboratory data	Tetra Tech	TBD	TBD	Data validation report	TBD
Prepare TDD report	Tetra Tech	TBD	TBD	TBD	TBD

Notes:

HASP	Health and safety plan
NA	Not applicable
SAP	Sampling and analysis plan
TBD	To be determined
TDD	Technical direction document

Requirements:

Tetra Tech will develop a project-specific schedule for each TDD. Each site-specific SAP will include a schedule showing the anticipated start and completion dates of all major milestones, including field sampling events, laboratory analyses, data validation, and report preparation and submittal. Worksheet #16 is a generic schedule that can be used to develop project-specific schedules.

QAPP WORKSHEET #17
SAMPLING DESIGN AND RATIONALE

Describe and provide a rationale for choosing the sampling approach. Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations).

Sampling activities for each project will be outlined in a site-specific sampling and analysis plan (SAP). The SAP will summarize the sample network design and rationale, including: the numbers and types of samples to be collected, sampling locations, sampling frequencies, sample matrices, and measurement parameters. Key factors to be evaluated in the sampling process design include:

- Project objectives and decisions to be made
- Information needed for the decisions and how the information will be used
- Time and resource constraints
- Statistical validity and legal defensibility of the data

Completing this evaluation (1) helps ensure that the analytical results obtained fully support the decisions to be made by data users and (2) maximizes the probability of making correct decisions based on the results.
The sampling network design and rationale will be coordinated with the data quality objective (DQO) process described in Worksheets #10 and 11. The ultimate use of the data, as defined by the DQO process, will help determine whether grab or composite samples should be collected or whether a probability-based (statistical) data collection design or a nonrandom (judgmental) data collection design should be used.
The site-specific SAP will also distinguish between screening data used for information purposes only (noncritical measurements) and definitive data used to meet project objectives (critical measurements). If field screening techniques will be used to identify samples for confirmative laboratory analysis, the site-specific SAP will indicate what techniques will be used and the frequency of confirmative sampling.

The site-specific will include figures showing sampling locations and a summary table of investigative and quality control samples to be collected, similar to the information presented in Worksheet #20.

QAPP WORKSHEET #18
SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS

Matrix	Sampling Location/ID Number	Depth (if applicable)	Analytical Group	Sampling SOP Reference[a]	Rationale for Sampling Location
Groundwater	MW-23	15-20 feet bgs	VOCs	Tetra Tech SOP015-2	Downgradient well
Soil	SS-06	0-6 inches bgs	PCBs	Tetra Tech SOP005-2	Area near transformer spill
Air	AA-02	NA	VOCs	ERT SOP #1704	Area downwind of drums

Notes:

a See Worksheet #21 for identification of sampling SOPs

bgs Below ground surface
ERT Environmental Response Team
NA Not applicable
PCB Polychlorinated biphenyl
SOP Standard operating procedure
VOC Volatile organic compound

Requirements:

Because of the general nature of this QAPP, project-specific sampling method requirements cannot be described. However, Worksheet #18 has been partially completed with example information to illustrate the level of detail required for project-specific sampling and analysis plans (SAP). The project-specific SAP should address:

- Methods used to select sample locations for all sample matrices
- Project-specific modifications to sampling procedures outlined in SOPs
- Sampling equipment for all sample matrices and all sampling locations
- Decontamination procedures for sampling equipment (including drilling equipment)
- Procedures for handling and disposing of investigation-derived wastes such as well construction wastes, decontamination fluids, and disposable sampling equipment
- Procedures for providing unique sample identification numbers to accurately correlate analytical results and field information with sampling locations and field monitoring stations

QAPP WORKSHEET #19
ANALYTICAL SOP REQUIREMENTS

Matrix	Analytical Group	Concentration Level	Analytical Methods[a]	Sample Volume and Containers	Preservation Requirements	Maximum Holding Time[b] (Preparation/Analysis)
Water	VOCs	Trace, low	SW-846 8260B CLP SOM02.1	Three 40-mL glass vials with Teflon®-lined septum	To pH < 2 with hydrochloric acid; store at 4 degrees C	NA/14 days
Water	SVOC	SIM, low	SW-846 8270D CLP SOM02.1	Two 1,000-mL amber glass bottles with Teflon®-lined caps	Store at 4 degrees C	7 days/40 days
Water	Pesticides and herbicides	NA	SW-846: 8081B, 8151A CLP SOM02.1	Two 1,000-mL amber glass bottles with Teflon®-lined caps	Store at 4 degrees C	7 days/40 days
Water	PCBs	NA	SW-846 8082A CLP SOM02.1	Two 1,000-mL amber glass bottles with Teflon®-lined caps	Store at 4 degrees C	7 days/40 days
Water	Dioxins and furans	NA	SW-846 8290A CLP DLM02.2	Two 1,000-mL amber glass bottles with Teflon®-lined cap	Store at 4 degrees C	30 days/45 days
Water	Metals (except mercury)	ICP-AES, ICP-MS	SW-846 6010C, 6020A CLP ISM01.3	One 1,000-mL glass or polyethylene bottle	To pH < 2 with nitric acid; store at 4 degrees C	NA/180 days
Water	Mercury	NA	SW-846 6010C, 6020A, 7470A CLP ISM02.1	One 1,000-mL glass or polyethylene bottle	To pH < 2 with nitric acid; store at 4 degrees C	NA/28 days
Water	Cyanide	NA	SW-846 9012B CLP ISM02.1	One 1,000-mL glass or polyethylene bottle	To pH > 12 with sodium hydroxide; store at 4 degrees C (if residual chlorine is present, add 0.6 grams of ascorbic acid)	14 days
Water	TCLP VOCs	NA	SW-846 1311/8260B	One 4-ounce glass bottle	Store at 4 degrees C	14 days/14 days
Water	TCLP SVOCs	NA	SW-846 1311/8270D	One 1,000-mL glass bottle	Store at 4 degrees C	14 days/7 days/40 days[c]
Water	TCLP Metals	NA	SW-846 1311/6010C, 6020A, 7470A	One 1,000-mL glass bottle	Store at 4 degrees C	180 days/180 days 28 days/28 days (mercury)

QAPP WORKSHEET #19 (CONTINUED)
ANALYTICAL SOP REQUIREMENTS

Matrix	Analytical Group	Concentration Level	Analytical Methods[a]	Sample Volume and Containers	Preservation Requirements	Maximum Holding Time[b] (Preparation/Analysis)
Soil, Sediment, Waste	VOCs	Low, medium	SW-846 5035A, 8260B CLP: SOM02.1	(1) Two 40-mL glass vials with Teflon®-lined caps (2) Two pre-labeled, pre-weighed 40-mL glass vials with Teflon®-lined septum caps, containing magnetic stir bars and sodium bisulfate solution (3) Three coring tool samplers containing 5 grams of soil plus one 40-mL glass vile with Teflon®-lined cap	Freeze from -7 to -15 degrees C or store at 4 degrees C	NA/14 days (if frozen) NA/48 hours (if stored at 4 degrees C)
Soil, Sediment, Waste	SVOCs	Low, medium	SW-846 8270D CLP SOM02.1	One 8-ounce glass jar with Teflon®-lined cap	Store at 4 degrees C	14 days/40 days
Soil, Sediment, Waste	Pesticides, herbicides	NA	SW-846 8081B, 8151A CLP SOM02.1	One 8-ounce glass jar with Teflon®-lined cap	Store at 4 degrees C	14 days/40 days
Soil, Sediment, Waste	PCBs	NA	SW-846 8082A CLP SOM02.1	One 8-ounce glass jar with Teflon®-lined cap	Store at 4 degrees C	14 days/40 days
Soil, Sediment, Waste	Dioxins and furans	NA	SW-846 8280B, 8290A CLP DLM02.2	One 8-ounce glass jar with Teflon®-lined cap	Store at 4 degrees C	30 days/45 days
Soil, Sediment, Waste	Metals (except mercury)	ICP-AES, ICP-MS	SW-846 6010C, 6020A CLP ISM02.1	One 8-ounce glass jar	Store at 4 degrees C	NA/180 days
Soil, Sediment, Waste	Mercury	NA	SW-846 6010C, 6020A, 7471B CLP ISM01.3	One 8-ounce glass jar	Store at 4 degrees C	NA/28 days
Soil, Sediment, Waste	Cyanide	NA	SW-846 9012B CLP ISM02.1	One 8-ounce glass jar	Store at 4 degrees C	14 days
Soil, Sediment, Waste	TCLP VOCs	NA	SW-846 1311/8260B	One 8-ounce glass jar with zero headspace	Store at 4 degrees C	14 days/14 days

QAPP WORKSHEET #19 (CONTINUED)
ANALYTICAL SOP REQUIREMENTS

Matrix	Analytical Group	Concentration Level	Analytical Methods[a]	Sample Volume and Containers	Preservation Requirements	Maximum Holding Time[b] (Preparation/Analysis)
Soil, Sediment, Waste	TCLP SVOCs	NA	SW-846 1311/8270D	One 8-ounce glass jar	Store at 4 degrees C	14 days/7 days/14 days[c]
Soil, Sediment, Waste	TCLP Metals	NA	SW-846 1311/6010C, 6020A, 7471B	One 8-ounce glass jar	Store at 4 degrees C	180 days/180 days 28 days/28 days (mercury)
Air	VOCs	NA	TO-15 CLP SAV01.X	6-liter Summa canister	None	30 days

Notes:

a See Worksheet 23 for analytical methods
b Holding time is measured from the time of sample collection to the time of sample extraction and analysis
c SVOC holding times for Method 1311 include times for leachate/extraction/analysis of sample

C	Celsius
CLP	Contract Laboratory Program
ICP-AES	Inductively coupled plasma-atomic absorption spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
mL	Milliliter
NA	Not applicable
PCB	Polychlorinated biphenyl
SIM	Selected ion monitoring
SVOC	Semivolatile organic compound
VOC	Volatile organic compound

QAPP WORKSHEET #20
FIELD QUALITY CONTROL SAMPLE SUMMARY

Matrix	Analytical Group	Analytical SOP Reference[a]	No. of Sampling Locations	No. of Samples	No. of Field Duplicates[b]	No. of MS/MSDs[b]	No. of Equipment Rinsate Blanks[b]	No. of Trip Blanks[b]	Total No. of Samples to Laboratory
Water	VOCs	A1, A2	TBD	TBD	1 in 10	1 in 20	As needed	1 per cooler	TBD
	SVOCs	A1, A5	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Pesticides	A1, A7	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Herbicides	A8	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	PCBs	A1, A6	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Dioxins/furans	A9, A10	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Metals	A11, A12, A13	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Mercury	A11, A14	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Cyanide	A11, A16	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
Soil, sediment, and waste	VOCs	A1, A2	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	SVOCs	A1, A5	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Pesticides	A1, A7	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Herbicides	A8	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	PCBs	A1, A6	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Dioxins/furans	A9, A10	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Metals	A11, A12, A13	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Mercury	A11, A15	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
	Cyanide	A11, A16	TBD	TBD	1 in 10	1 in 20	As needed	NA	TBD
Air	VOCs	A3, A4	TBD	TBD	1 in 10	NA	NA	NA	TBD

Notes:
a See Worksheet #23 for identification of analytical methods
b See discussion of field quality control samples in "Requirements" section below for specific guidelines and frequencies.

MS/MSD Matrix spike/matrix spike duplicate
NA Not applicable
PCB Polychlorinated biphenyl
SOP Standard operating procedure
SVOC Semivolatile organic compound
TBD To be determined
VOC Volatile organic compound

QAPP WORKSHEET #20
FIELD QUALITY CONTROL SAMPLE SUMMARY

Requirements:

Field QC samples will be collected and analyzed to assess the quality of data generated from sampling activities. These samples may include field duplicates, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment rinsate blanks, and trip blanks.

Field duplicate samples are independent samples collected as close as possible in space and time to the original investigative sample. The field duplicate sample is collected immediately after the original sample, using the same collection method. Care should be taken to collect the field duplicate sample as close to the location of the original sample as possible. Field duplicate samples can measure how sampling and field procedures influence the precision of an environmental measurement. They can also provide information on the heterogeneity of a sampling location. Typically, field duplicates are collected at a frequency of one for every 10 investigative samples of the same matrix type.

MS/MSD samples are typically collected for analysis by organic methods, and often for analysis by inorganic methods. Solid MS/MSDs usually require no extra volume. Liquid MS/MSD samples are usually collected from a single sampling location at triple the normal sample volume. MS and matrix duplicate samples are typically collected for inorganic analysis. The MS sample and matrix duplicate sample are usually collected from a single location at double the normal sample volume. In the laboratory, MS/MSD samples and MS samples are spiked with known amounts of analytes. Matrix duplicate samples are not spiked. Analytical results of MS/MSDs are used to measure the precision and accuracy of the laboratory organic analytical program and MS samples are used to measure the accuracy of the inorganic analytical program. Matrix duplicate sample are used to measure the precision of the inorganic analytical program. Each of these QC samples is typically collected and analyzed at a frequency of one for every 20 investigative samples per matrix.

Equipment rinsate blanks are collected when non-disposable sampling equipment is used. These blanks assess the cleanliness of sampling equipment and the effectiveness of equipment decontamination. Equipment rinsate blanks are collected by pouring analyte-free water over surfaces of cleaned sampling equipment that contact sample media. Equipment rinsate blanks are collected after sampling equipment has been decontaminated but prior to being reused for sampling. Equipment rinsate blanks are typically collected for each type of decontaminated sampling equipment.

Trip blanks are used to assess the potential for sample contamination during handling, shipment, and storage. Trip blanks are sample bottles filled by the analytical laboratory with organic-free water. The trip blanks are sealed and transported to the field; kept with empty sample bottles and then with the investigative samples throughout the field effort; and returned to the laboratory for analysis with the investigative samples. Trip blanks are never opened in the field. One trip blank is usually included within every shipping cooler of liquid samples to be analyzed for VOCs.

Additional field QC samples include field blanks and split samples.

Field blanks are samples of the same or similar matrix as the actual investigative samples that are exposed to the sampling environment or equipment at the time of sampling. They are used to assess contamination resulting from ambient conditions. For aqueous samples, field blanks consist of analyte-free water such as degasified organic-free water for VOC analysis, High-performance liquid chromatography-grade water for SVOC analysis, and deionized or demineralized water for inorganic analyses. Field blanks are generally not required for solid matrices but may be collected on a case-by-case basis. Typically, one field blank is collected for every 10 or fewer liquid investigative samples.

Split samples are usually a set of two or more samples taken from a larger homogenized sample. The larger sample is usually collected from a single sampling location, but can also be a composite sample. Split samples can be sent to two or more laboratories and are used to compare data between the laboratories. Regulatory agencies involved in a project may request that split samples be collected to monitor how closely laboratories are meeting project-specific QA objectives.

QAPP WORKSHEET #21
PROJECT SAMPLING SOP REFERENCES

Reference Number	SOP Title (and Revision Date or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 001-2	Site Reconnaissance and Characterization (Nov 1999)	Tetra Tech	PPE, survey instruments, logbook	TBD	
SOP 002-3	General Equipment Decontamination (Jun 2009)	Tetra Tech	Scrub brushes, wash tubs, squirt bottles, water, decontamination solutions	TBD	
SOP 003-3	Organic Vapor Air Monitoring (Jul 2009)	Tetra Tech	Survey instruments, calibration gases, logbook	TBD	
SOP 005-2	Soil Sampling (Jun 2009)	Tetra Tech	Spoons, spatulas, triers, shovels, augers, core samplers, sample containers	TBD	
SOP 006-4	Sediment and Sludge Sampling (May 2010)	Tetra Tech	Spoons, spatulas, scoops, coring devices, sample containers	TBD	
SOP 007-2	Bulk Materials Sampling (Dec 1999)	Tetra Tech	Scoops, trowels, triers, spoons, grain thieves, sample containers	TBD	
SOP 008-2	Containerized Liquid, Sludge, and Slurry Sampling (Jan 2000)	Tetra Tech	Glass tubes, COLIWASA, bung remover, sample containers	TBD	
SOP 009-4	Surface Water Sampling (Jun 2009)	Tetra Tech	Dipper, point source bailer, Kemmerer sampler, peristaltic pump, sample containers	TBD	
SOP 010-4	Groundwater Sampling (Jun 2009)	Tetra Tech	Water level indicator, bailers, pumps, sample containers	TBD	
SOP 011-2	Field Measurement of Water Temperature (Nov 1999)	Tetra Tech	Thermometer, sample container, logbook	TBD	
SOP 012-3	Field Measurement of pH (Nov 1999)	Tetra Tech	pH meter, buffer solutions, sample container, logbook	TBD	
SOP 013-2	Field Measurement of Specific Conductance (Nov 1999)	Tetra Tech	Specific conductance meter, standard solutions, thermometer, sample container, logbook	TBD	
SOP 014-1	Static Water Level, Total Well Depth, and Immiscible Layer Measurement (Jul 2009)	Tetra Tech	Electric water level meter	TBD	
SOP 015-2	Groundwater Sample Collection Using Low-Flow Sampling Methodology (Nov 2014)	Tetra Tech	Adjustable flow rate pump, multi-parameter meter, water level indicator, sample containers	TBD	

QAPP WORKSHEET #21 (CONTINUED)
PROJECT SAMPLING SOP REFERENCES

Reference Number	SOP Title (and Revision Date or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-019-7	Packaging and Shipping Samples (Nov 2014)	Tetra Tech	Coolers; ice; packing materials; tape; plastic bags for samples and to line cooler; custody forms and seals		
SOP 020-4	Monitoring Well Installation (Apr 2009)	Tetra Tech	Tremie pipe and funnel; bentonite pellets; grouting supplies; casing, well screen, filter pack, and surface completion materials	TBD	
SOP 021-4	Monitoring Well Development (Jun 2009)	Tetra Tech	Pumps, air compressors, bailers, surge blocks	TBD	
SOP 024-2	Recording Notes in Field Logbooks (Nov 2014)	Tetra Tech	Logbook, pen with permanent ink	TBD	
SOP-030-0	Aquifer Pump Testing (Nov 2014)	Tetra Tech	Submersible pump, electric water level indicator, pressure transducer, electronic data logger, stop watch, logbook	TBD	
SOP-031-0	Aquifer Slug Testing (Nov 2014)	Tetra Tech	Tape measure, pressure transducer, electric water level indicator, slug of known volume, stop watch, logbook	TBD	
SOP 052-1	Measurement of Stream or Pond Stage (Dec 1999)	Tetra Tech	Standard staff gauge, wire-weight gauge, logbook	TBD	
SOP 061-2	Field Measurement of Groundwater Indicator Parameters (Jul 2009)	Tetra Tech	Multi-parameter water quality measuring system, standard solutions, logbook	TBD	
SOP 064-2	Calibration of Air Sampling Pump (Nov 1999)	Tetra Tech	Air sampling pump, digital calibrator	TBD	
SOP 065-0	Colorimetric Indicator Detectors (Dräeger Tubes) (Nov 1999)	Tetra Tech	Dräeger tubes, hand pump, logbook	TBD	
SOP 073-1	Air Quality Monitoring (Nov 1999)	Tetra Tech	Air sampling pump with collection media, Summa canister	TBD	
SOP 074-2	Soil Gas Sampling Methods (Jul 2009)	Tetra Tech	Sampling pump, port, line; or Summa canister with pump for purging	TBD	
SOP# 1704	Summa Canister Sampling (Nov 2015)	EPA ERT	Summa canisters, flow controllers, vacuum gauges	TBD	
SOP #1720	Operation of the Niton XLt792YW Field Portable X-Ray Fluorescence Instrument (Dec 2015)	EPA ERT	Niton XRF analyzer, battery pack, battery charger, soil sampling accessories	TBD	
SOP #1733	Area Clearance for Indoor Mercury Spills (Mar 2015)	EPA ERT	Direct-reading mercury vapor instrument with data logging capability	TBD	

QAPP WORKSHEET #21 (CONTINUED)
PROJECT SAMPLING SOP REFERENCES

Reference Number	SOP Title (and Revision Date or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP #2004	Sample Packing and Shipping (Jun 2015)	EPA ERT	Coolers; ice; packing materials; tape; plastic bags for samples and to line cooler; custody forms and seals	TBD	
SOP #2006	Sampling Equipment Decontamination (Dec 2015)	EPA ERT	Scrub brushes, wash tubs, water, decontamination solutions	TBD	
SOP #2007	Groundwater Well Sampling (Jun 2015)	EPA ERT	Water level indicator, bailers, pumps, tubing, sample containers	TBD	
SOP #2008	General Air Sampling Guidelines (Nov 1994)	EPA ERT	Direct reading instruments, logbook	TBD	
SOP #2009	Drum Sampling (Nov 1994)	EPA ERT	Drum opening devices, bung wrench, glass thieving tubes or COLIWASA, overpack materials	TBD	
SOP #2010	Tank Sampling (Nov 1994)	EPA ERT	Weighted tape line, sludge judge, glass thieves, bailers, COLIWASA, sample containers	TBD	
SOP #2011	Chip, Wipe, and Sweep Sampling (Aug 2015)	EPA ERT	Brush, chisel, sample containers	TBD	
SOP #2012	Soil Sampling (Jul 2001)	EPA ERT	Spades, shovels, spatulas, scoops, spoons, trowels, augers, tube samplers, split spoons, sample containers	TBD	
SOP #2013	Surface Water Sampling (Feb 2002)	EPA ERT	Kemmerer bottles, dip sampler, sample containers	TBD	
SOP #2015	Asbestos Sampling (Nov 1994)	EPA ERT	Sampling pumps, batteries, filter cassettes	TBD	
SOP #2016	Sediment Sampling (Nov 2001)	EPA ERT	Spades, shovels, scoops, trowels, augers, sediment coring devices, dredges, sample containers	TBD	
SOP #2017	Waste Pile Sampling (Mar 2002)	EPA ERT	Spades, shovels, scoops, spoons, trowels, tube samplers, triers, sample containers	TBD	
SOP #2037	Terrestrial Plant Community Sampling (Oct 1994)	EPA ERT	Stakes, plot frames, shovels, pruning shears or knives, plant field guide	TBD	
SOP #2038	Vegetation Assessment Field Protocol (Jun 1996)	EPA ERT	Stakes of flags, shovels, soil moisture/pH probe, pruning shears or knives, plant field guide	TBD	
SOP #2042	Soil Gas Sampling (Apr 2001)	EPA ERT	Soil gas probe, vacuum box, Tedlar bags, tubing and fittings, Summa canisters	TBD	

QAPP WORKSHEET #21 (CONTINUED)
PROJECT SAMPLING SOP REFERENCES

Reference Number	SOP Title (and Revision Date or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP #2043	Manual Water Level Measurements (May 2013)	EPA ERT	Well depth measurement device, logbook or data forms	TBD	
SOP #2044	Monitoring Well Development (Jun 2015)	EPA ERT	Air compressors, pumps, air lines, surge blocks, generators	TBD	
SOP #2045	Controlled Pumping Tests (May 2015)	EPA ERT	Submersible pump, electric water level indicator, pressure transducer, electronic data logger, stop watch, logbook	TBD	
SOP #2046	Slug Tests (Dec 2015)	EPA ERT	Tape measure, pressure transducer, electric water level indicator, slug of known volume, stop watch, logbook	TBD	
SOP #2048	Monitor Well Installation (Jul 2001)	EPA ERT	Tremie pipe and funnel; bentonite pellets; grouting supplies; casing, well screen, filter pack, and surface completion materials	TBD	
SOP #2049	Investigation Derived Waste Management (Oct 2015)	EPA ERT	Drums, buckets, trash bags, containers, decontamination supplies	TBD	
SOP #2050	Operation of the Model 6620 GT Geoprobe (Jun 2015)	EPA ERT	Geoprobe sampling device, threaded rods, drive caps, slotted well points, mini-bailers, tubing, sample containers	TBD	
SOP #2056	Operation of Ground Penetrating Radar (Sep 2010)	EPA ERT	GPR system with antennae, cables, batteries, data logger	TBD	
SOP #2074	Field Description of Soil and Sediment Borings (Dec 2015)	EPA ERT	Coring device, spatula, tape measure, Munsell color charts, logbook	TBD	
SOP #2082	Construction and Installation of Permanent Sub-Slab Soil Gas Wells (Mar 2007)	EPA ERT	Hammer drill or rotary hammer, extension cord, portable vacuum cleaner, tubing, fittings	TBD	
SOP #2084	Activity-Based Air Sampling for Asbestos (May 2007)	EPA ERT	Personal air sampling pumps, high volume pumps, filter cassettes, tubing	TBD	
SOP #2101	Retrieving Meteorological Information (Dec 1994)	EPA ERT	Remote meteorological station, computer connection	TBD	
SOP #2102	Tedlar Bag Sampling (Sep 2001)	EPA ERT	Vacuum box, pumps, Tedlar bags, tubing, fittings	TBD	
SOP #2103	Charcoal Tube Ambient Air Sampling (Oct 1994)	EPA ERT	Air sampling pumps, charcoal tubes, tubing, fittings, air sampling data sheets	TBD	
SOP #2104	Tenax/CMS Tube Sampling (Oct 1994)	EPA ERT	Air sampling pumps, Tenax/CMS tubes, tubing, fittings, air sampling data sheets	TBD	

QAPP WORKSHEET #21 (CONTINUED)
PROJECT SAMPLING SOP REFERENCES

Reference Number	SOP Title (and Revision Date or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP #2119	Air Sampling for Metals [NIOSH Method 7300 Elements] (Aug 2001)	EPA ERT	Air sampling pumps, filter cassettes, tubing, fittings, air sampling data sheets	TBD	
SOP #2121	High Volume Polyurethane Foam Sampling (Aug 1995)	EPA ERT	PUF samplers, sample modules, calibration device, air sampling data sheets	TBD	
SOP #2130	Operation of DryCal DC-Lite Primary Flow Calibrator (Dec 2015)	EPA ERT	Flow calibrator, tubing, charger, instruction manual	TBD	
SESDPROC-305-R3	Potable Water Supply Sampling (May 2013)	EPA Region 4	Sample containers, logbook, custody forms, packaging and shipping materials	TBD	

Notes:

ERT Environmental Response Team
SOP Standard operating procedure
TBD To be determined

Requirements:

Sampling methods and equipment will be selected to meet project objectives. Affected media may include groundwater, surface water, sediment, surface and subsurface soils, wastes, process materials, and air. Field parameters (such as pH, specific conductance, oxidation-reduction potential, temperature, dissolved oxygen content, meteorological parameters, and water elevation) may also be measured to assist in carrying out sampling procedures effectively.

To the extent possible, Tetra Tech will rely on EPA-approved methods for sample collection and field measurements. EPA-approved sampling methods selected for use will be referenced in the site-specific SAP. These include methods developed by EPA's Environmental Response Team (ERT) and the EPA Region 4 Science and Ecosystem Support Division (SESD). ERT SOPs are available on line at the following addresses (EPA 2016c):

https://www.epaosc.org/site/doc_list.aspx?site_id=2107&category=Field%20Activities
https://www.epa.gov/quality/quality-system-and-technical-procedures-sesd-field-branches

If an EPA-approved sampling method is not available, or a non-standard sampling method is required, Tetra Tech will use an internal SOP or will describe the sampling method in the site-specific SAP. The Tetra Tech SOPs listed in Worksheet #21 were reviewed in accordance with an internal QC program. Many of these SOPs have been reviewed and approved by EPA as portions of QAPPs and SAPs prepared under various Tetra Tech contracts and have been successfully implemented by Tetra Tech in the field.

QAPP WORKSHEET #22
FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person
MultiRAE PRO w/ppB Sensor (Non-wireless)	Zero unit in ambient air or with Zero value calibration gas; span calibrate the LEL/O2/H2S/CO sensors using quad mix calibration gas. Span calibrate PID sensor with Isobutylene calibration gas.	Check pump flow with Bios calibrator to ensure appropriate flow; change moisture filter routinely	Bump test	Prior to each day's activity; any anomaly suspected	Calibration acceptable within +/- 2% of span gas value	Replace battery or replace unit	Equipment vendor
MiniRAE 3000	Zero calibrate unit in ambient air or with Zero value calibration gas. Span calibrate PID senor using Isobutylene 100ppm span gas	Check / Replace battery / Clean tip or bulb if necessary; Check pump flow with Bios calibrator to ensure appropriate flow; change moisture filter routinely	Bump Test	Prior to each day's activity; any anomaly suspected	Calibration acceptable within +/- 2% of span gas value	Replace battery or replace unit	Equipment vendor
UltraRAE 3000	Zero calibrate unit in ambient air or with Zero value calibration gas. Use 1 benzene SEP tube and calibrate span to 5 ppm benzene concentration	Check / Replace battery / Clean tip or bulb if necessary; Check pump flow with Bios calibrator to ensure appropriate flow; change moisture filter routinely	Bump Test	Prior to each day's activity; any anomaly suspected	Calibration acceptable within +/- 2% of span gas value	Replace battery or replace unit	Equipment vendor

QAPP WORKSHEET #22 (CONTINUED)
FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person
Thermo Scientific TVA 1000B	Annual manufacturer's calibration	Check calibration date on tag or sticker; need rechargeable NiCd battery	NA	Prior to each day's activity; any anomaly suspected	FID: zero <5000 counts Span Counts= 175-250 per ppm methane PID: zero <2000 counts Span Counts= 3500-6000 per ppm isobutylene (response factors)	Check batteries, bulbs, and filters; service if needed	Equipment vendor
Thermo Scientific PDR-1000	Place in included zero bag. Run zero-calibration function. Automatically counts down to zero.	Used compressed air to blow inside optical chamber to remove excess particle residue. If post calibration readings result in "Background Too High" message additional cleaning is required with isopropyl alcohol and cotton swab.	Test battery and memory check using internal menu options	Prior to each day's activity; any anomaly suspected	FID: zero <5000 counts Span Counts= 175-250 per ppm methane PID: zero <2000 counts Span Counts= 3500-6000 per ppm isobutylene (response factors)	Check batteries, bulbs, and filters; service if needed	Equipment vendor
GPS (Trimble Geo XT)	None	Data extraction and post-processing	Turn unit on. Start GPS program. Synchronize with satellites.	Prior to use	NA	NA	Equipment vendor
Ludlum Micro-R Meter - Model 19	Annual factory calibration	Replace alkaline batteries when required	Replace alkaline batteries when required	Prior to use	Within range: 0 to 5,000 µR/hr No alarm	Check batteries, Cesium 137 1 µCi, check source	Equipment vendor
Ludlum 192	Annual factory calibration	Replace alkaline batteries when required	Replace alkaline batteries when required	Prior to use	Within range: 0 to 5,000 µR/hr Alarm fixed and deviation	Check batteries, Cesium 137 1 µCi, check source	Equipment vendor

QAPP WORKSHEET #22 (CONTINUED)
FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person
Dräeger Accuro 2000 Pump	None	None	Squeeze hand pump and place finger over tube chamber to ensure suction and no air leaks.	Prior to use	No leaks	Return to equipment vendor for replacement	Equipment vendor
Lumex 915+	Annual factory calibration	Replace alkaline batteries when required	Replace alkaline batteries when required	Prior to use	<20 %R of the S_k (based on saturated mercury vapor tables) deviation	If %R (based on the S_k value and the readings by the analyzer) is above 20% call tech support	Equipment vendor
Horiba U-52	Vendor will calibrate meter before rental pick up	Replace alkaline batteries when required	Test pH and conductivity using standard buffer solutions	Prior to Use	Unit automatically identifies out-of-calibration results. Calibration accepted within range of standard solutions.	Recalibrate or return to vendor	Equipment vendor
Gil Air 5 with 5 unit base charger	Use with Bios Flow Calibrator to monitor air flow. Use screwdriver to adjust air flow to desired rate.	Use with Bios Flow Calibrator to monitor air flow. Use screwdriver to adjust air flow to desired rate.	Run pump for 8-hour period to ensure battery life remains greater than 8 hours.	After use	Failure to maintain charge for 8-hour period	Return to equipment vendor for replacement	Equipment vendor
Bios Defender - M	Annual factory calibration	Place unit on charge routinely	Connect to air sampling pump to ensure flow testing capability	Occasionally; any anomaly suspected	Inconsistent calibration results	Return to equipment vendor for replacement	Equipment vendor

Notes:

%R Percent recovery
µCi Microcurie
µR Microrad
FID Flame ionization detector
GPS Global positioning system
NA Not applicable
NiCd Nickel-cadmium
PID Photoionization detector
ppm Part per million

QAPP WORKSHEET #22 (CONTINUED)
FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

Requirements:

General requirements for testing, inspection, and maintenance procedures for the START contract are as follows. Testing, inspection, and maintenance methods and frequency will be based on the type of instrument; its stability characteristics; the required accuracy, sensitivity, and precision; its intended use, considering project-specific data quality objectives (DQO); manufacturer's recommendations; and other conditions affecting measurement or operational control. For most instruments, preventive maintenance is performed according to procedures and schedules recommended in (1) the instrument manufacturer's literature or operating manual or (2) standard operating procedures (SOP) associated with particular applications of the instrument. In such cases, site-specific sampling and analysis plans (SAP) will reference these documents for the testing, inspection, and maintenance procedures and schedules to be used. The site-specific SAP will also reference these documents or will describe how the availability of critical spare parts will be assured and maintained for instruments used for the project. In some cases, testing, inspection, and maintenance procedures and schedules may differ from the manufacturer's specifications or SOPs. This can occur when a field instrument is used to make critical measurements. In these situations, any special testing, inspection, and maintenance procedures and schedules will be outlined in the site-specific SAP.

Any field instrument that is in disrepair or is out of calibration must be segregated, clearly marked, and not used until it is repaired and recalibrated. If an instrument is repeatedly broken or out of calibration, the instrument must be replaced or repaired so that it is in good working order. When the condition of an instrument is suspect, unscheduled testing, inspection, and maintenance should be conducted. Adherence to these field preventive maintenance practices is subject to verification during performance and system audits.

Field Environmental Instruments, Inc. (Field), Tetra Tech's team subcontractor, will provide most of the field equipment and instruments that will be used under the START contract. Field is responsible for (1) thoroughly checking and calibrating each instrument before shipment to the field and (2) including instructions for field calibration, testing, and maintenance of each instrument shipped. Once in the field, Tetra Tech field team leaders assume responsibility for testing, inspection, and maintenance of field instruments and equipment.

Field equipment and instruments will be inspected for damage upon arrival in the field. Damaged equipment and instruments will be immediately replaced or repaired. Battery-operated equipment will be checked to assure full operating capacity; if needed, batteries are recharged or replaced. Critical spare parts such as tape, paper, pH probes, electrodes, batteries, and battery chargers will be kept on site to minimize equipment downtime. Backup instruments, equipment, and additional spare parts will be available on site or can be shipped to the site within 1 day to avoid delays in the field schedule.

Equipment used for field measurements under the START contract will be maintained and calibrated with sufficient frequency and in such a manner that the accuracy and reproducibility of results are consistent with the manufacturer's specifications and with project-specific DQOs. As noted above, Field will have primary responsibility for initial equipment calibrations before shipping the instruments to the field. The manufacturer's operating manual and instructions that accompany the equipment will be consulted to ensure that all calibration procedures are followed. Calibration procedures, frequency, standards, control limits, and corrective action for commonly used field equipment are also addressed in the SOPs listed in Worksheet #21.

Following use, field equipment will be properly decontaminated prior to being returned to the equipment vendor. When the equipment is returned, copies of any field notes regarding equipment problems will be included so that problems are not overlooked and any necessary equipment repairs are carried out.

QAPP WORKSHEET #23
ANALYTICAL SOP REFERENCES

Reference Number	Title, Revision, Date, and/or Number[a]	Definitive or Screening Data	Analytical Group	Instruments	Organization Performing Analysis[b]	Modified for Project Work?[b]
A1	SOM02.3 (EPA Contract Laboratory Program Statement of Work for Organic Superfund Methods, Multi-Media, Multi-Concentration, September 2015)	Definitive	VOCs, SVOCs, PCBs, Pesticides	GC/ECD, GS/MS	TBD	TBD
A2	SW-846 8260B (Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry)	Definitive	VOCs	GC/MS	TBD	TBD
A3	SAV01.X (EPA Contract Laboratory Program Statement of Work for Volatile Organics Analysis in Air, June 2008)	Definitive	VOCs	GC/MS	TBD	TBD
A4	TO-15 (Determination Of Volatile Organic Compounds [VOCs] In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/ Mass Spectrometry, January 1999)	Definitive	VOCs	GC/MS	TBD	TBD
A5	SW-846 8270D (Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry)	Definitive	SVOCs	GS/MS	TBD	TBD
A6	SW-846 8082A (Polychlorinated Biphenyls [PCBs] by Gas Chromatography)	Definitive	PCBs	GC/ECD	TBD	TBD
A7	SW-846 8081B (Organochlorine Pesticides by Gas Chromatography)	Definitive	Pesticides	GC/ECD	TBD	TBD
A8	SW-846 8151A (Chlorinated Herbicides by GC Using Methylation or Pentafluorobenzylation Derivatization)	Definitive	Herbicides	GC/ECD	TBD	TBD
A9	DLM02.2 (EPA Analytical Services Branch Statement of Work for Analysis of Chlorinated Dibenzo-p-dioxins [CDDs] and Chlorinated Dibenzofurans [CDFs], Multi-Media, Multi-Concentration, December 2009)	Definitive	Dioxins/furans	HRGC/HRMS	TBD	TBD
A10	SW-846 8290A (Polychlorinated Dibenzodioxins [PCDDs] and Polychlorinated Dibenzofurans [PCDFs] by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry)	Definitive	Dioxins/furans	HRGC/HRMS	TBD	TBD

QAPP WORKSHEET #23 (CONTINUED)
ANALYTICAL SOP REFERENCES

Reference Number	Title, Revision, Date, and/or Number[a]	Definitive or Screening Data	Analytical Group	Instruments	Organization Performing Analysis[b]	Modified for Project Work?[b]
A11	ISM02.3 (EPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, Multi-Media, Multi-Concentration, September 2015)	Definitive	Metals (including mercury and cyanide)	ICP-AES, ICP-MS, CVAA, Spectrophotometer	TBD	TBD
A12	SW-846 6010C (Inductively Coupled Plasma-Atomic Emission Spectrometry)	Definitive	Metals (including mercury)	ICP-AES	TBD	TBD
A13	SW-846 6020A (Inductively Coupled Plasma-Mass Spectrometry)	Definitive	Metals (including mercury)	ICP-MS	TBD	TBD
A14	SW-846 7470A (Mercury in Liquid Waste – Manual Cold-Vapor Technique)	Definitive	Mercury	CVAA	TBD	TBD
A15	SW-846 7471B (Mercury in Solid or Semisolid Waste – Manual Cold-Vapor Technique)	Definitive	Mercury	CVAA	TBD	TBD
A16	SW-846 9012B (Total and Amenable Cyanide – Automated Colorimetric, with Off-Line Distillation)	Definitive	Cyanide	Spectrophotometer	TBD	TBD

Notes:

a EPA Contract Laboratory Program (CLP) analytical methods are available at: http://www2.epa.gov/clp/contract-laboratory-program-analytical-statements-work-sows
EPA SW-846 analytical methods are available at: http://www3.epa.gov/epawaste/hazard/testmethods/sw846/online/
EPA Toxic Organic Compendium (TO) analytical methods are available at: http://www.epa.gov/ttn/amtic/airtox.html

b The site-specific SAP will identify the laboratories that have been selected to provide analytical services and whether analytical methods must be modified to meet TDD objectives. Laboratories that might analyze samples include the EPA Region 5 Central Regional Laboratory (CRL), EPA CLP laboratories, and subcontracted laboratories.

CDD	Chlorinated dibenzo-p-dioxin
CDF	Chlorinated dibenzofuran
CVAA	Cold vapor atomic absorption
GC/ECD	Gas chromatography/electron capture detector
GC/MS	Gas chromatography/mass spectrometry
HRGC/HRMS	High-resolution gas chromatography/high-resolution mass spectrometry
ICP/AES	Inductively coupled plasma/atomic absorption spectrometry
ICP/MS	Inductively coupled plasma/mass spectrometry
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
SVOC	Semivolatile organic compound
TBD	To be determined
VOC	Volatile organic compound

QAPP WORKSHEET #23 (CONTINUED)
ANALYTICAL SOP REFERENCES

Requirements:

Laboratory analytical methods will vary with each investigation conducted under the START contract and will be identified in the site-specific SAP. To select appropriate methods for sample preparation, cleanup, and analysis, Tetra Tech will consider the specific parameters of interest, sample matrices, and minimum detectable concentrations needed to accomplish project DQOs. Whenever possible, Tetra Tech will select methods from SW-846 (EPA 2009b), CLP statements of work (EPA 2008, 2009c, 2009d, 2015b, and 2015c, EPA Toxic Organic methods (EPA 1999), or the most recent updates). If these sources do not include an analytical method consistent with DQOs, Tetra Tech will review other EPA-approved methods such as those specified in *Methods for Chemical Analysis of Water and Wastes* (EPA 1983).

When EPA-approved methods are not available or appropriate for project-specific requirements, other recognized standard analytical methods, such as those published by the American Public Health Association (APHA), American Society for Testing and Materials (ASTM), or the National Institute for Occupational Safety and Health (NIOSH), may be used. Guidance documents containing these analytical methods include:

- Standard Methods for the Examination of Water and Waste Water (APHA 2012)
- ASTM Annual Book of Standards (ASTM 2014)
- NIOSH Manual of Analytical Methods (NIOSH 2003)

The published methods mentioned above are updated at various time intervals. Unless otherwise stated, laboratories conducting work under the START contract will use the most current version of any specified analytical method.

QAPP WORKSHEET #24
ANALYTICAL INSTRUMENT CALIBRATION

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[a]
GC/ECD	Pesticides: Run five calibration standard solutions and a blank PCBs: Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria	Always, resolution per SOP Initial, CF RSD ≤ 20% Continuing, CF %D ≤ 15 for opening and ≤ 50 for closing	Inspect the system for problems, change the column, bake out the detector, clean the injection port, and take other CAs to achieve the acceptance criteria.	Laboratory Analyst	A1, A6, A7, A8
GC/MS	VOCs: Run five calibration standard solutions and a blank SVOCs: Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria	Always, RRF ≥ 0.010 or per SOP Initial, RSD ≤ 20% or 40%, depending on compound. Continuing, %D ≤ 25 or 40 depending on compound	Inspect the system for problems, clean the ion source, change the column, service the purge and trap device, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A1, A2, A5
GC/MS	Run five calibration standard solutions and a blank	24- hour continuing calibration acceptance criteria	Always, RRF ≥ 0.010 or per SOP Initial, RSD ≤ 30%, but one or two analytes may be ≤40%. Continuing, %D ≤ 30%, tracked on control chart	Inspect the system for problems, clean the ion source, change the column, service the purge and trap device, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A3, A4
HRGC/HRMS	Run five calibration standard solutions and a blank	12-hour continuing calibration acceptance criteria	Always, S/N ≥10, ion abundance ratios per SOP Initial, RSD ≤20% Continuing, RSD ≤20% (unlabeled compounds) and ≤30% (labeled compounds)	Inspect the system for problems, clean the ion source, change the column, service the purge and trap device, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A9, A10
ICP-AES	Daily calibration curve with at least blank and five standard solutions. Curve must have correlation coefficient of at least 0.998.	Each CCV analyzed shall reflect the conditions of analysis of all associated analytical samples (the preceding 10 analytical samples or the preceding analytical samples up to the previous CCV)	Deviation from the initial calibration verification: metals 90-110%	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A12

QAPP WORKSHEET #24 (CONTINUED)
ANALYTICAL INSTRUMENT CALIBRATION

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[a]
ICP-MS	Daily calibration curve with at least blank and five standard solutions. Curve must have correlation coefficient of at least 0.998.	Each CCV analyzed shall reflect the conditions of analysis of all associated analytical samples (the preceding 10 analytical samples or the preceding analytical samples up to the previous CCV)	Deviation from the initial calibration verification: metals 90-110%	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A13
CVAA, AAS	Daily calibration curve with at least blank and three standards solutions. Curve must be linear and have a correlation coefficient of at least 0.995.	Verify calibration curve at the end of each analysis batch and/or after every 10 samples using a continuing calibration blank (CCB) and CCV standard	CCV standard within ±10% of its true value and the CCB must not contain target analytes at or above quantitation limit	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A14, A15
Spectrophotometer	Run at least six calibration standard solutions and a blank. Calibration curve must be linear and have a correlation coefficient of at least 0.995.	Daily or once every 24 hours, each time the instrument is set up, or after any calibration failure.	Deviation from the ICV or CCV within 85-115%	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A16

Notes:

a See Worksheet #23 for identification of analytical methods

%D Percent difference
AAS Atomic adsorption spectrophotometry
CCB Continuing calibration blank
CCV Continuing calibration verification
CF Calibration factor
CVAA Cold vapor atomic adsorption
GC/ECD Gas chromatography/electron capture detector
GC/MS Gas chromatography/mass spectrometry
HPLC High performance liquid chromatography
ICE-AES Inductively coupled plasma/atomic emission spectrometry
ICP-MS Inductively coupled plasma/mass spectrometry

QAPP WORKSHEET #24 (CONTINUED)
ANALYTICAL INSTRUMENT CALIBRATION

ICV	Initial calibration verification
PCB	Polychlorinated biphenyl
RSD	Relative standard deviation
RRF	Relative response factor
S/N	Signal-to-noise ratio
SOP	Standard operating procedure
SVOC	Semivolatile organic compound
VOC	Volatile organic compound

Requirements:

Laboratory equipment used to analyze samples collected under the START contract will be calibrated based upon written SOPs maintained by the laboratory. Calibration records (including the dates and times calibration and the names of the personnel performing the calibration) will be filed at the location where the analytical work is performed and maintained by the laboratory personnel performing QC activities. Calibration records will be subject to QA audits. Laboratory analyses under the START contract may be conducted by the EPA Region 5 Central Regional Laboratory (CRL), Contract Laboratory Program (CLP) laboratories, or subcontractor laboratories. The laboratory QA managers are responsible for ensuring that laboratory instruments are calibrated in accordance with the requirements in this QAPP and in any site-specific SAP.

When analyses are conducted in accordance with SW-846 or CLP methods, calibration procedures and frequencies specified in the relevant method should be followed as closely as possible. The site-specific SAP should provide any additional calibration requirements (such as equipment requiring calibration, calibration procedures, requirements for calibration standards, requirements for maintaining calibration records and traceability, calibration frequency, acceptance criteria, number of calibration points, and internal or external standards) that deviate from or are not specified in the published EPA-approved method. Such deviations will be outlined in the site-specific SAP or in an appendix as part of a laboratory SOP.

For analytical methods that are not EPA-approved, a complete SOP including the calibration procedures for the method will be included as an appendix to the site-specific SAP. Laboratory SOPs describing calibration procedures for such non-standard methods should include the following information:

- Detailed calibration procedure for each instrument used
- Internal standard or external standard calibration requirements and procedures
- Calibration requirements for confirmatory results (second column, second detector, mass spectral confirmation, and so forth)
- Frequency of calibration and continuing calibration checks
- Number of calibration standards used, concentrations, and preparation methods
- Traceability of calibration standards and continuing calibration check standards
- Numerical acceptance criteria for initial calibration and continuing calibration checks
- Corrective action procedures for situations where calibration procedures are not performed properly, or calibration acceptance criteria are not met
- Instructions for recording calibration information and results, including information to be recorded and where information is recorded and stored

QAPP WORKSHEET #25
ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

Instrument/ Equipment	Maintenance Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference[a]
GC/ECD	Daily check, calibration verification	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	Daily before use	See A1, A6, A7, A8	Inspect the system for problems, change the column, bake out the detector, and clean the injection port.	Laboratory Analyst	A1, A6, A7, A8
GC/MS	Daily check, instrument tune with bromofluorobenzene (VOC) or Decafluorotriphenylphosphine (SVOC)	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	Daily before use	See A1, A2, A5	Inspect the system for problems, clean the ion source, change the column, and service the purge and trap device.	Laboratory Analyst	A1, A2, A5
GC/MS	Daily check, instrument tune with bromofluorobenzene	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	Daily before use	See A3, A4	Inspect the system for problems, clean the ion source, change the column, and service the sample injection port.	Laboratory Analyst	A3, A4
HRGC/HRMS	Daily check instrument tune with PFK. Before initial calibration, verify SIM mass spectral data acquisition with performance check solution.	Injector syringe, injector septum, injector liner/seal, injector port, guard column, column splitter, analytical column, ion source, detector, traps, and gas supply	Daily before use	See A9, A10	Inspect the system for problems, clean the ion source, change the column, and service the sample injection port.	Laboratory Analyst	A9, A10
ICP-AES	Daily check, calibration verification	Nebulizer, injection tube, plasma optimization, gas supply, and detector	Daily before use	See A11, A12	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A12

QAPP WORKSHEET #25 (CONTINUED)
ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

Instrument/ Equipment	Maintenance Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference[a]
ICP-MS	Daily check, calibration verification	Nebulizer, injection tube, plasma optimization, gas supply, and detector	Daily before use	See A11, A13	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A13
CVAA, AAS	Daily check, calibration verification	Nebulizer, injection tube, flame optimization, gas supply, and detector	Daily before use	See A11, A14, A15	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria.	Laboratory Analyst	A11, A14, A15
Spectrophotometer	Daily check, calibration verification	Check connections, valves/flow rates, temperature settings, and other items specified by instrument manufacturer	Daily before use	See A11, A16	Inspect the system for problems, clean the system, verify operating conditions, and take CAs to achieve the technical acceptance criteria	Laboratory Analyst	A11, A16

Notes:

a See Worksheet #23 for identification of analytical methods.

AAS	Atomic adsorption spectrometry
CA	Corrective action
CVAA	Cold vapor atomic adsorption
GC/ECD	Gas chromatography/electron capture detector
GC/MS	Gas chromatography/mass spectrometry
HRGC/HRMS	Inductively coupled plasma/atomic emission spectrometry
HPLC	High performance liquid chromatography
ICE-AES	Inductively coupled plasma/atomic emission spectrometry
ICP-MS	Inductively coupled plasma/mass spectrometry
PFK	Perfluorokerosene
SIM	Selected ion monitoring

Requirements:

Laboratories conducting analyses of samples collected under the START contract are required to have a preventative maintenance program covering testing, inspection, and maintenance procedures and schedules for each measurement system and required support activity. This program is usually documented in the form of SOPs for each analytical instrument to be used. The basic requirements and components of such a program include the following:

- Each laboratory will implement, as a part of its QA/QC program, a routine preventive maintenance program to minimize the occurrence of instrument failure and other system malfunctions.
- Service and repair of instruments, equipment, tools, gauges, and so forth will be performed by an internal group of qualified personnel. Alternatively, scheduled instrument maintenance and emergency repair may be provided by manufacturers' representatives under a repair and maintenance contract.
- Instrument maintenance will be carried out by the laboratory on a regular schedule. The servicing of critical items should be scheduled to minimize the downtime of measurement systems. A list of critical spare parts for each instrument will be identified by the laboratory and requested from the manufacturer. These spare parts will be stored at the laboratory to reduce downtime. The availability of spare parts will be monitored periodically.
- Testing, inspection, and maintenance procedures described in laboratory SOPs will be in accordance with manufacturer's specifications and with the requirements of the specific analytical methods employed.
- Maintenance and service must be documented in service logbooks to provide a complete maintenance history. A separate service logbook should be kept for each instrument. Maintenance records will be traceable to the specific instrument, equipment, tool, or gauge.
- Records produced as a result of testing, inspection, or maintenance of laboratory instruments will be maintained and filed at the laboratory. These records will be available for review by internal and external laboratory system audits under the START contract.

QAPP WORKSHEET #26
SAMPLE HANDLING SYSTEM

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Tetra Tech field sampling team
Sample Packaging (Personnel/Organization): Tetra Tech field sampling team
Coordination of Shipment (Personnel/Organization): Tetra Tech field sampling team
Type of Shipment/Carrier: Federal Express for priority shipments; local courier service or direct pick-up by laboratory if this option is available
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample custodian for CLP laboratory, EPA Region 5 CRL, or subcontracted laboratory
Sample Custody and Storage (Personnel/Organization): Sample custodian for CLP laboratory, EPA Region 5 CRL, or subcontracted laboratory
Sample Preparation (Personnel/Organization): Laboratory analyst for CLP laboratory, EPA Region 5 CRL, or subcontracted laboratory
Sample Determinative Analysis (Personnel/Organization): Laboratory analyst for CLP laboratory, EPA Region 5 CRL, or subcontracted laboratory
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 30 days after delivery of analytical data package unless otherwise specified
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days after delivery of analytical data package unless otherwise specified
Biological Sample Storage (No. of days from sample collection): 30 days after delivery of analytical data package unless otherwise specified
SAMPLE DISPOSAL
Personnel/Organization: Sample custodian for CLP laboratory, EPA Region 5 CRL, or subcontracted laboratory
Number of Days from Analysis: 30 days after delivery of analytical data package unless otherwise specified

Notes:

CLP Contract Laboratory Program
CRL Central Regional Laboratory
EPA U.S. Environmental Protection Agency

QAPP WORKSHEET #27
SAMPLE CUSTODY REQUIREMENTS

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Samples collected by Tetra Tech under the START contract must be traceable from the point of collection through analysis and final disposition to ensure sample integrity. Sample integrity helps ensure the legal defensibility of the analytical data and subsequent conclusions. The team will use standard EPA procedures and software (such as SCRIBE) to identify, track, monitor, and maintain sample chain-of-custody for. Chain-of-custody records will establish the documentation necessary to trace sample possession from collection through analysis and final disposition. Each person retaining custody at any time throughout the sample history is responsible for maintaining proper documentation and control measures. A sample is under a person's custody if it:

- Is in that person's possession
- Is in that person's view after being in his or her possession
- Is in that person's possession and he or she places it in a secured location
- Is placed by that person in a designated secure area

All projects conducted by Tetra Tech under the START contract will follow sample and document control procedures, sample and evidence identification procedures, field records requirements and procedures, and chain-of-custody procedures outlined in the *Contract Laboratory Program Guidance for Field Samplers* (EPA 2014c). Samples will be packaged and labeled for shipment in compliance with current U.S. Department of Transportation (DOT) and International Air Transport Association (IATA) dangerous goods regulations. Any additional requirements stipulated by the overnight carrier will be followed. Tetra Tech will use EPA's SCRIBE environmental data management software to manage sample collection, documentation, chain of custody, and reporting under the START contract. Field personnel will input data into SCRIBE and then use the software to generate sample labels, bottle tags, and chain-of-custody forms, and to track samples from the field to the laboratory. Because SCRIBE captures sample management information electronically, the information is easily exportable to databases or various reporting formats.

Chain-of-custody forms will be signed in ink by the samplers and the individual relinquishing custody. Tetra Tech will then follow the sample packaging and shipment procedures summarized below to ensure that samples arrive at the laboratory with the chain of custody intact.

- Immediately after sample collection, sample containers will be labeled with the appropriate identifiers, and clear tape will be placed over the labels to prevent smearing.
- The samples will be placed in Ziploc™ plastic bags and then in a cooler containing double sealed bags of ice and maintained at 4^{o} C. The cooler will remain in a secured area or in view of the sampler until it is properly sealed for shipment to the laboratory.
- Prior to shipping, the chain-of-custody forms, airbills, and all other relevant documents will be completed. Chain-of-custody forms will be sealed in plastic bags and taped to the inside of the cooler lid. Cushioning material, such as bubble-wrap, will be placed in the cooler.
- A temperature blank consisting of a jar or vial containing water will be included in every cooler, and will be used by the laboratory to determine the cooler temperature at the time of sample receipt.
- The shipping cooler will then be sealed with tape and custody seals in a manner that will indicate whether the cooler was opened. The preferred procedure includes placing custody seals at diagonally opposite corners of the cooler. The custody seals will be covered with clear plastic tape or strapping tape.

QAPP WORKSHEET #27 (CONTINUED)
SAMPLE CUSTODY REQUIREMENTS

The field sampler is personally responsible for the care and custody of the samples until they are transferred to other Tetra Tech personnel or properly dispatched to an overnight carrier or directly to a laboratory. As few people as possible should handle the samples to prevent loss, breakage, or potential contamination. When transferring possession of the samples, the individuals relinquishing and receiving the samples sign, date, and note the time of transfer on the chain-of-custody form. Commercial carriers are not required to sign off on the chain-of-custody form as long as the form is sealed inside the sample cooler and the custody seals remain intact.

Sample Identification Procedures:

Field logbooks provide the means of recording all data collection activities performed. Logbook entries will include much detail as possible so that a particular situation can be reconstructed without relying on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel but will be stored in the secure location when not in use. Each logbook will be identified by a project-specific document number. The title page of each logbook will contain the following information:

- Person to whom the logbook is assigned
- Logbook number
- Project name
- Project start and end dates

Logbook entries will be made in ink and no erasures will be made. If an incorrect entry is made, the incorrect information will be crossed out, initialed, and dated by the person making the correction. Logbook entries will contain a variety of information. The beginning of each entry will note the date, start time, weather conditions, names of team members present, facility visitors present and the purpose of their visit, level of personal protection used, and signature of the person making the entry.

Whenever a sample is collected or a measurement is taken, a detailed description of the sampling or measurement location, which may include global positioning (GPS) coordinates, will be recorded in the logbook. The number and description of any photographs taken of the location will also be noted. All equipment used to take measurements will be identified along with the date of equipment calibration. The equipment used to collect samples will be noted along with the time of sampling, sample description, depth at which the sample was collected, sample volume, number of containers, and sample preservation method. The number, type, and location of QC samples will also be noted in the logbook. Field logbooks will also describe any issues encountered during data collection and how these issues were resolved.

In addition to field logbooks, Tetra Tech will use a variety of electronic tools to collect and store field data under the START contract. These tools include:

- Capturx™ – An ink-to-digital system that allows transfer of information written in ink on pre-configured field sheets to a digital system seamlessly imported into SCRIBE
- Viper – A data collection system developed by EPA's Environmental Response Team (ERT) that couples hardware and software with field instruments to report real-time information to a web-based console
- Rapid Assessment Tool (RAT) – An EPA-developed data collection system that couples hardware and software with certain field instruments to record data in a Microsoft Access database

QAPP WORKSHEET #27 (CONTINUED)
SAMPLE CUSTODY REQUIREMENTS

- PDF fillable forms – Forms that can be populated using free software such as Adobe Reader and that use dropdowns and pick lists to speed data entry and increase quality by standardizing field values
- ArcPad – A product that allows true geographic information system (GIS) and data collection functionality in the field by coupling mobile devices and GPS units for high-accuracy data collection.

GPS data collection tools – Tools such as Garmin GPS units coupled with GeoSetter software, for use in documenting and geo-tagging images

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Custody procedures must be followed in the laboratory from sample receipt until the sample is discarded. The procedures required for this contract must be at least as stringent as those required by the EPA Contract Laboratory Program (CLP) statements of work (EPA 2008, 2009c, 2009d, 2015b, and 2015c, or the most recent updates). These procedures are briefly described in this section.

The laboratory should designate a specific person as the sample custodian, with an alternate designated to act in the custodian's absence. The custodian will receive incoming samples and indicate receipt by signing the accompanying custody forms and retaining copies of the signed forms as permanent records. Once the sample transfer process is complete, the laboratory is responsible for maintaining internal logbooks, lab tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory sample custodian will record pertinent information concerning the sample, including the persons delivering and receiving the sample, the date and time received, the method by which the sample was transmitted to the laboratory, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample identification number, and any unique laboratory identification number associated with the sample. This information should be entered into a computerized laboratory information management system (LIMS).

The laboratory must provide a secure storage area, restricted to authorized personnel, for all samples. The custodian will ensure that samples that are heat- or light-sensitive, radioactive, have other unusual physical characteristics, or require special handling are properly stored and maintained prior to analysis. Only the custodian can distribute samples to laboratory personnel authorized to conduct the required analyses. Laboratory analytical personnel are responsible for the care and custody of the sample upon receipt. These personnel must be prepared to testify that the sample was in their custody at all times from the moment they received it from the custodian until the time that the analyses were completed.

At the completion of sample analysis, any unused portion of the sample, together with identifying labels, must be returned to the custodian. The returned tagged sample should be retained in secure storage until the custodian receives permission to dispose of the sample. Sample disposal will occur only on the order of the laboratory director, in consultation with EPA or Tetra Tech, or when it is certain that the information is no longer required or the samples have deteriorated. Likewise, tags and laboratory records will be maintained until the information is no longer required and final disposition is ordered by the laboratory director, in consultation with EPA or Tetra Tech.

QAPP WORKSHEET #28
QC SAMPLES

Matrix	Water
Analytical Group	VOCs, TCLP VOCs
Concentration Level	Trace, Low
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A2 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	**Frequency/ Number**	**Corrective Action (CA)**	**Person(s) Responsible for CA**	**DQI**	**Measurement Performance Criteria**
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds (Surrogates)	All samples	Reanalyze sample. If on reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet # 12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level	SIM, Low
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A5 (See Worksheet # 23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds (Surrogates)	All samples	Reanalyze sample. If on reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet # 12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	Pesticides
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A7 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	**Frequency/ Number**	**Corrective Action (CA)**	**Person(s) Responsible for CA**	**DQI**	**Measurement Performance Criteria**
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	Herbicides
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21
Analytical Method/ SOP Reference	A8 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R as presented in Worksheet #12
Laboratory Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	PCBs
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A6 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	Dioxins/Furans
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A9, A10 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Water
Analytical Group	Metals, Mercury, Cyanide, TCLP Metals
Concentration Level	ICP-AES or ICP-MS for Metals, NA for Mercury and Cyanide
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A11, A12, A13, A14, A16 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R as presented in Worksheet #12
Laboratory Duplicate	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	RPD as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	VOCs, TCLP VOCs
Concentration Level	Low, Medium
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A2 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds (Surrogates)	All samples	Reanalyze sample. If on reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	SVOCs, TCLP SVOCs
Concentration Level	SIM, Low, Medium
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A5 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Deuterated Monitoring Compounds (Surrogates)	All samples	Reanalyze sample. If on reanalysis, the monitoring compound meets criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	Pesticides
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A7 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	Herbicides
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A8 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R as presented in Worksheet #12
Laboratory Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	PCBs
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A1, A6 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike/Matrix Spike Duplicate	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R and RPD as presented in Worksheet #12
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Surrogate Spike	All samples	Reanalyze sample. If upon reanalysis, the surrogate meets criteria, report reanalysis results. If upon reanalysis, the surrogate does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	30-150 %R

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste
Analytical Group	Dioxins/Furans
Concentration Level	NA
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A9, A10 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Laboratory Control Sample	1 per analytical batch, 20 samples maximum	Perform corrective action as needed. If problems continue, recalibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Soil/Sediment/Waste				
Analytical Group	Metals, Mercury, Cyanide, TCLP Metals				
Concentration Level	ICP-AES or ICP-MS for Metals, NA for Mercury and Cyanide				
Sampling SOP	Various (See Worksheet #21)				
Analytical Method/ SOP Reference	A11, A12, A13, A15, A16 (See Worksheet #23)				
Sampler's Name/ Organization	TBD/Tetra Tech				
Analytical Organization	TBD				
No. of Sampling Locations	See Worksheet #18				
QC Sample	**Frequency/ Number**	**Corrective Action (CA)**	**Person(s) Responsible for CA**	**DQI**	**Measurement Performance Criteria**
Method Blank	1 per extraction batch samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected extracts.	Laboratory Analyst	Accuracy/Bias Contamination	No target compounds > QL
Matrix Spike	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	%R as presented in Worksheet #12
Laboratory Duplicate	1 per extraction batch of 20 samples maximum	If sufficient volume is available, extract and reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Accuracy and Precision	RPD as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Matrix	Air/Soil Gas
Analytical Group	VOCs
Concentration Level	SIM, Scan
Sampling SOP	Various (See Worksheet #21)
Analytical Method/ SOP Reference	A3, A4 (See Worksheet #23)
Sampler's Name/ Organization	TBD/Tetra Tech
Analytical Organization	TBD
No. of Sampling Locations	See Worksheet #18

QC Sample	Frequency/ Number	Corrective Action (CA)	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	1 per batch samples maximum	If sufficient volume is available, reanalyze samples in affected batch. If sufficient volume is not available, reanalyze affected samples.	Laboratory Analyst	Accuracy/Bias-Contamination	No target compounds > QL
Laboratory Control Sample	1 per batch of 20 samples maximum	Perform maintenance as needed. If problems continue, re-calibrate instrument.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Internal Standards	All samples	Reanalyze sample. If upon reanalysis, the monitoring compounds meet criteria, report reanalysis results. If upon reanalysis, the monitoring compound does not meet criteria, the results are reported in the narrative.	Laboratory Analyst	Accuracy	%R as presented in Worksheet #12
Laboratory Duplicate	1 per batch of 20 samples maximum	If sufficient volume is available, reanalyze samples in affected batch. Otherwise, analyze laboratory control sample to see if problem is analysis or sample.	Laboratory Analyst	Precision	RPD as presented in Worksheet #12

QAPP WORKSHEET #28 (CONTINUED)
QC SAMPLES

Notes:

%R	Percent recovery
CA	Corrective Action
DQI	Data quality indicator
PCB	Polychlorinated biphenyl
QL	Quantitation limit
RPD	Relative percent difference
SIM	Selected ion monitoring
SOP	Standard operating procedure
SVOC	Semivolatile organic compound
TBD	To be determined
TCLP	Toxicity characteristic leaching procedure
VOC	Volatile organic compound

QAPP WORKSHEET #29
PROJECT DOCUMENTS AND RECORDS

Document	Where Maintained
Sampling and Analysis Plans, Work Plans, Health and Safety Plans	Field office, Tetra Tech project files, EPA administrative record
Field notes and logbooks	Field office, Tetra Tech project files
Chain-of-custody records	Tetra Tech project files
Field forms	Tetra Tech project files
Audit/assessment checklists, forms, and reports	Tetra Tech project files
Corrective action forms and reports	Tetra Tech project files
Laboratory equipment calibration logs	Laboratory
Laboratory sample preparation logs	Laboratory
Laboratory run logs	Laboratory
Sample disposal records	Laboratory
Laboratory data packages	Tetra Tech project files
Data verification and validation records	Tetra Tech project files
Validated data	Tetra Tech project files, EPA administrative record
Project reports	Tetra Tech project files, EPA administrative record

Requirements:

This worksheet summarizes general requirements for managing data under the START contract for Region 5. Further detail and requirements will be provided as necessary in site-specific sampling and analysis plans (SAP), including requirements for data recording, validation, transformation, transmittal, reduction, analysis, tracking, storage, and retrieval. If necessary, site-specific SAPs will also provide checklists and standard forms for detecting and correcting errors and preventing the loss of data during data reduction, reporting, encoding, and entry.

Data for the START contract will be obtained from a combination of sources, including field measurements and laboratory analyses. The process of data gathering is a coordinated effort and will be conducted by project staff in conjunction with data producers. Laboratory data will be obtained from analytical laboratories in EDD format in addition to the required hard copy analytical data packages. Acceptable electronic data deliverable (EDD) formats for the contract include the Environmental Response Laboratory Network EDD and EPA's Staged Electronic Data Deliverable (SEDD).

Data tracking is imperative to ensure timely, cost-effective, and high-quality results. Data tracking begins with sample chain-of-custody. When the analytical laboratory receives the samples into custody, the laboratory will send a sample acknowledgment to Tetra Tech. The sample acknowledgment will confirm the sample receipt, condition, and the required analyses.

When directed by EPA, Tetra Tech will validate data generated under the START contract as described in Worksheets #34 through 36. As a part of the data validation process, EDDs will be reviewed against the hard copy deliverables to ensure accurate transfer of data. In addition, the hard copy will be evaluated for calculation errors. As a result of the data validation, qualifiers will be placed on the data to indicate the data usability. These qualifiers will also be placed into the electronic data file. Upon approval of the data set with the appropriate data qualifiers, the electronic data will be released to the project manager for reporting.

Following data validation and release of data, Tetra Tech project managers will use data to prepare project reports. As a part of the quality control (QC) review of the final report, the data will be further checked by technical reviewers and a quality control coordinator (QCC) to verify its accuracy.

Tetra Tech will maintain reports, analytical data, field records, and other documents generated under the START contract within the final project file at a secure location. Tetra Tech will retain project documents for the 10-year time period specified by EPA or until EPA requests transfer or disposition of the documents.

QAPP WORKSHEET #30
ANALYTICAL SERVICES

Matrix	Analytical Group	Concentration Level	Analytical SOP[a]	Data Package Turnaround Time[b]	Laboratory[c]	Backup Laboratory[c]
Water	VOCs	Trace, low	A1, A2	21 days	TBD	TBD
	SVOCs	SIM, low	A1, A5	21 days	TBD	TBD
	Pesticides	NA	A1, A7	21 days	TBD	TBD
	Herbicides	NA	A8	21 days	TBD	TBD
	PCBs	NA	A1, A6	21 days	TBD	TBD
	Dioxins/furans	NA	A9, A10	21 days	TBD	TBD
	Metals	ICP-AES, ICP-MS	A11, A12, A13	21 days	TBD	TBD
	Mercury	NA	A11, A14	21 days	TBD	TBD
	Cyanide	NA	A11, A16	21 days	TBD	TBD
Soil, sediment, waste	VOCs	Low, medium	A1, A2	21 days	TBD	TBD
	SVOCs	Low, medium	A1, A5	21 days	TBD	TBD
	Pesticides	NA	A1, A7	21 days	TBD	TBD
	Herbicides	NA	A8	21 days	TBD	TBD
	PCBs	NA	A1, A6	21 days	TBD	TBD
	Dioxins/furans	NA	A9, A10	21 days	TBD	TBD
	Metals	ICP-AES, ICP-MS	A11, A12, A13	21 days	TBD	TBD
	Mercury	NA	A11, A15	21 days	TBD	TBD
	Cyanide	NA	A11, A16	21 days	TBD	TBD
Air	VOCs	NA	A3, A4	21 days	TBD	TBD

Notes:

a See Worksheet #23 for identification of analytical methods
b 21 days is listed as a standard turnaround time. Site-specific sampling and analysis plans (SAP) will include the turnaround time required for the TDD.
c Samples will be analyzed by EPA Contract Laboratory Program (CLP) laboratories, the EPA Region 5 Central Regional Laboratory (CRL), or subcontracted laboratories. The site-specific SAP will identify the specific laboratory that will be used.

NA Not applicable
ICP-AES Inductively coupled plasma-atomic emission spectrometry
ICP-MS Inductively coupled plasma-mass spectrometry
PCB Polychlorinated biphenyl
SIM Selected ion monitoring
SVOC Semivolatile organic compound
TDD Technical direction document
VOC Volatile organic compound

QAPP WORKSHEET #30 (CONTINUED)
ANALYTICAL SERVICES

Requirements:

The source of analytical services to be provided will in part be determined by data quality objectives (DQO), the intended use of the resulting data, and technical direction document (TDD) requirements and constraints such as quick turnaround of data. For some TDDs, Tetra Tech will obtain analytical services from the EPA Region 5 Central Regional Laboratory (CRL) or through EPA Contract Laboratory Program (CLP) laboratories. However, if the EPA laboratories are overloaded, unable to implement a specific analytical method, or unable to achieve quantitation limits required by DQOs, the required analytical services will be provided by subcontractor laboratories procured by Tetra Tech. The site-specific SAP will identify the specific laboratory that has been selected to provide analytical services. An analytical service request form will be used for laboratory services that are subcontracted by Tetra Tech under the START contract. This form will contain basic information, modified as needed to meet project-specific requirements. The form will be submitted to EPA with the site-specific SAP and to the laboratory performing the analyses. The form will include the following information:

- General description of analytical service requested
- Number and types of samples to be collected
- Purpose of analysis
- Estimated dates of sample collection
- Dates and methods of sample shipment
- Holding time requirements
- Analytical protocols required, including method, detection limits, reporting limits, precision, and accuracy
- Special technical instructions if outside the scope of analytical protocol
- Required data deliverables and number of days after sample receipt that the data will be required
- Other additional requirements
- Sampling and shipping contact information
- Project-specific data reduction or validation criteria

On rare occasions, project-specific conditions might require the use of an analytical method that is not an EPA-approved or standard method. These methods will typically be provided by the laboratory performing the analysis and will include a detailed description of sample preparation, instrument calibration, sample analyses, method sensitivity, associated QA/QC requirements, and acceptance criteria. The laboratory must provide method performance study information to confirm the performance of the method for each applicable matrix; if previous performance studies are not available, they must be developed during the project and included as part of the project results.

Site-specific SAPs will provide the data reporting requirements for physical and chemical field and laboratory analyses that are conducted during the investigation. Data reporting requirements will depend on the DQOs and on the intended uses of the resulting data. Reporting requirements must be clearly specified as part of

QAPP WORKSHEET #30 (CONTINUED)
ANALYTICAL SERVICES

any request for analytical services and are closely linked to data validation requirements (see Worksheets #34 through 36). The site-specific SAP will clearly specify the data that must be reported such that (1) data validation requirements can be satisfied and (2) attainment of DQOs can be verified.

When complete laboratory data packages are required for START TDDs, the data packages will typically contain the following information:

- Case narrative, including a statement of samples received, a description of any deviations from the specified analytical method, explanations of data qualifiers applied to the data, and any other significant problems encountered during analysis. The narrative will describe all QC nonconformances experienced during sample analysis, along with the corrective actions taken.
- Table that cross-references field and laboratory sample numbers
- Chain-of-custody forms pertaining to each sample delivery group or sample batch analyzed
- Laboratory report showing traceability to the sample analyzed and containing the following information: project identification; field sample number; laboratory sample number; sample matrix description; dates and times of sample collection, receipt at the laboratory, sample preparation, and analysis; analytical method description and reference citation; individual parameter results with concentration units (including second column results or second detector results, or other confirmatory results, where appropriate); quantitation limits achieved; and dilution or concentration factors
- Data summary forms and QC summary forms for sample results, surrogate results, blank results, field QC sample results, matrix spike (MS)/matrix spike duplicate (MSD) results, MS results, initial and continuing calibration results, confirmatory results, laboratory control sample (LCS) results, and other QC sample results
- Laboratory control charts
- Raw data such as chromatograms, peak areas, retention times for gas chromatography (GC) and high performance liquid chromatography (HPLC) analyses, mass spectra for gas chromatography/mass spectrometry (GC/MS) analyses, and laboratory bench sheets
- Method detection limits and instrument detection limits

Most laboratory data under the START contract will be reported in electronic format using SCRIBE. Acceptable electronic data deliverable (EDD) formats for the contract include the Environmental Response Laboratory Network EDD and EPA's Staged Electronic Data Deliverable (SEDD). Additional data deliverables may be required depending on project-specific DQOs or on the particular field or laboratory method used.

Tetra Tech project managers, in conjunction with the Tetra Tech START QA officer, have the primary responsibility for defining project-specific data reporting requirements. These requirements, the turnaround time for receipt of results and data packages, and any project-specific requirements for retention of samples and laboratory records, should be clearly defined in requests for analytical services. Subcontractor laboratory QA managers are responsible for ensuring that laboratory data reporting requirements in the site-specific SAPs are met.

QAPP WORKSHEET #31
PLANNED PROJECT ASSESSMENTS

Assessment Type[a]	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organization)	Person(s) Responsible for Responding to Assessment Findings (Title and Organization)	Person(s) Responsible for Identifying and Implementing CAs (Title and Organization)	Person(s) Responsible for Monitoring Effectiveness of CAs (Title and Organization)
Field audit	TBD	Internal	Tetra Tech	Auditors selected by Tetra Tech QA officer	Tetra Tech project manager and field personnel	Tetra Tech project manager	Tetra Tech QA officer
Laboratory audit	TBD	Internal	Tetra Tech	Auditors selected by Tetra Tech QA officer	Laboratory project manager, QA manager, and analytical personnel	Laboratory project manager and QA manager	Tetra Tech QA officer

Note:

a See requirements section below for activities typically reviewed during field and laboratory audits

Requirements:

Under the START contract, performance and system audits of both field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the procedures and requirements established in this QAPP and in any applicable site-specific SAP. Non-conforming items identified during an audit will be addressed by corrective action. This worksheet addresses basic audit requirements that apply to work conducted by Tetra Tech under the START contract. If additional project-specific audits are required by a TDD, these will be identified in the site-specific SAP.

While this worksheet focuses on audit activities related to environmental data operations, it should be noted that deliverables submitted by Tetra Tech under the START contract are subject to a three-level internal QC review process. This process includes a technical review by a technical staff member independent of the project team; an editorial review completed by a technical editor; and a final review by a quality control coordinator (QCC) for overall completeness and compliance with TDD requirements.

Performance and System Audits: Both internal performance and system audits may be conducted on Tetra Tech's field operations and subcontractor laboratories under the START contract. Performance audits include verification that field measurements and sampling activities and laboratory analyses are being conducted in accordance with the requirements of this QAPP and any site-specific SAP. System audits involve a qualitative examination of all components of an environmental data collection system, including records, personnel, and QA management activities.

QAPP WORKSHEET #31 (CONTINUED)
PLANNED PROJECT ASSESSMENTS

This worksheet describes the selection of audit personnel, the scope of field and laboratory audits, audit frequencies, and typical audit reports for internal audits initiated by Tetra Tech START QA officer. External performance and system audits initiated by EPA may also be conducted under the START contract and would involve similar activities.

Audit Personnel: Auditors must be independent of the activities being audited. The Tetra Tech START QA officer has the lead role in directing internal audit activities. The QA officer will select the appropriate personnel to conduct each internal audit and will assign them responsibilities and deadlines for completing their audits. These personnel may include the Tetra Tech START QA officer, QCCs for the project, or other independent auditors. When an audit team is required, the QA officer selects a lead auditor based on relevant technical expertise and audit experience. The lead auditor is responsible for selecting and preparing the audit team; preparing an audit plan; coordinating and scheduling the audit with the project team, subcontractor, or other organization being audited; participating in the audit; coordinating the preparation and issuance of audit reports and corrective action requests; and evaluating audit responses and resulting corrective actions.

Audit Scope of Work: Performance audits of field activities may be conducted to evaluate compliance with the requirements of this QAPP and site-specific SAPs. Field systems audits may include an examination of the following items:

- Sample collection records
- Sample handling, preservation, packaging, shipping, and custody records
- Equipment operation, maintenance, and calibration records

Laboratory performance audits include analysis of blind performance evaluation samples to assess a laboratory's ability to comply with QC limits. Laboratory systems audits may include evaluation of the following:

- Sample log-in, identification, storage, tracking, and custody procedures
- Sample and standards preparation procedures
- Availability of analytical instruments
- Analytical instrument operation, maintenance, and calibration records
- Laboratory security procedures
- Qualifications of analysts
- Project file organization and data handling procedures

QAPP WORKSHEET #31 (CONTINUED)
PLANNED PROJECT ASSESSMENTS

Audit Frequencies: Site-specific SAPs will provide a schedule of any planned audits that will be conducted during the investigation. These audits may be required by EPA or planned by the Tetra Tech START QA officer. Audit frequency will depend on several factors. In selecting projects for auditing, the QA officer will consider projects with a large volume of work or those on which EPA has placed a high level of importance. The QA officer may also randomly select projects for auditing. For laboratory audits, the QA officer will focus on subcontractor laboratories performing critical measurements (as determined by DQOs) or performing work for the first time under the START contract.

Unscheduled follow-up audits may occur if any deficiencies are discovered during an audit or review. Follow-up audits verify that corrective actions have been properly implemented to address deficiencies.

Audit Reports: Audit reports will be prepared for performance and system audits of field and laboratory activities and laboratory performance evaluation studies conducted under the START contract. Reports will be prepared by the lead auditor responsible for coordinating the audit. Audit reports will identify audit participants, describe the activity audited, summarize audit findings, and detail any deficiencies or deviations from protocol that were discovered during the audits, as well as any corrective actions that are proposed. Any field or laboratory analytical data that is generated during the analysis of blind performance evaluation samples must be validated. The validated data will be included with the audit report. Data validation procedures are addressed in Worksheets #34, 35, and 36.

Audit reports are distributed to the Tetra Tech START QA officer, program manager, project manager, and the laboratory subcontractor QA manager. The lead auditor has primary responsibility for ensuring that audits are conducted thoroughly and properly. Tetra Tech project managers and laboratory subcontractor QA managers are responsible for implementing corrective actions that result from an audit. The Tetra Tech START QA officer is responsible for verifying that recommended corrective actions have been implemented.

QAPP WORKSHEET #32
ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action (CA) Response Documentation	Individual(s) Receiving CA Response (Name, Title, Organization)	Timeframe for Response
Field audit	Audit report	Tetra Tech QA officer, program manager, and project manager	Within 7 days of completing audit	Written response, with detail depending on nature of CA	Lead auditor; Tetra Tech QA officer and program manager	Within 7 days of receiving audit report
Laboratory audit	Audit report	Tetra Tech QA officer, program manager, and project manager; laboratory subcontractor project manager and QA manager.	Within 7 days of completing audit	Written response, with detail depending on nature of CA	Lead auditor; Tetra Tech QA officer, program manager, and project manager	Within 7 days of receiving audit report

Requirements:

Rapid and thorough correction of QA problems, through an effective corrective action program, minimizes the possibility of questionable data or documentation. The two types of corrective action are immediate and long-term. Immediate corrective actions include correcting procedures, repairing instruments that are not working improperly, and correcting errors or deficiencies in documentation. Long-term corrective actions eliminate the sources of problems by correcting systematic errors in sampling and analytical procedures, revising procedures that produce questionable results, and manipulating similar cause-and-effect relationships.

QA problems and corrective actions applied are documented to provide a complete record of QA activities. These records assist the Tetra Tech START contract management team in identifying long-term QA problems and enable application of long-term corrective actions such as personnel training, replacement of instruments, and improvement of sampling and analytical procedures.

The Tetra Tech START QA officer has the authority to discontinue or limit environmental data collection activities that are compromised until corrective action is complete and data quality is no longer questionable. The QA officer may also order the recollection or reanalysis of samples or re-measurement of field parameters since the last documented evidence that the measurement system was in control.

Specific corrective action procedures for sample collection and field measurements and laboratory analyses are discussed below.

QAPP WORKSHEET #32 (CONTINUED)
ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Sample Collection and Field Measurements: Technical staff and project personnel involved in sample collection or field measurement activities are responsible for initiating routine corrective actions by reporting all suspected technical or QA nonconformances and deficiencies to the Tetra Tech project manager or field team leader. Corrective actions for sample collection and field measurements may include, but are not limited to, the following:

- Repeating measurements to check for error
- Checking that instruments are properly adjusted for ambient conditions such as temperature
- Checking batteries
- Checking calibration and recalibrating equipment if necessary
- Replacing the instrument or measurement devices
- Collecting additional samples
- Stopping work (if necessary)

Laboratory Analyses: Each laboratory that participates as a START subcontractor is required to have a written SOP that summarizes procedures for initiating, developing, approving, implementing, and documenting corrective action. The existence of such a program does not exempt the laboratory from following the corrective action requirements or additional requirements in any site-specific SAP. When errors, deficiencies, or out-of-control situations arise, systematic corrective actions must be taken to resolve problems and restore proper functioning analytical systems. Laboratory personnel and QA managers are alerted that corrective actions may be necessary if any of the following situations arise:

- Sample volumes are not sufficient to perform required analyses
- QC data are outside the acceptable limits for precision and accuracy
- Blanks contain contaminants above acceptable levels
- Undesirable trends are detected in spike recoveries or in the RPD between duplicates
- Unusual changes in detection limits arise
- Deficiencies are detected during internal or external audits or from the results of performance evaluation samples
- Inquiries concerning data quality are received from clients

If sample volumes are insufficient to complete the required analyses, the laboratory will notify the Tetra Tech project manager. The Tetra Tech project manager, Tetra Tech START QA officer, and laboratory subcontractor QA manager will contact the EPA on-scene coordinator (OSC) to determine if additional samples should be collected.

QAPP WORKSHEET #32 (CONTINUED)
ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Laboratory corrective action procedures are often initiated at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors; checks the instrument calibration; checks the spiking levels, calibration solutions, and standards; and checks instrument sensitivity. If the problem persists or cannot be identified, the matter may be referred to the laboratory supervisor, project manager, or QA manager for further investigation. Every effort must be made to determine the cause of the problem so that a permanent solution can be developed and implemented. Once a problem is resolved, full documentation of the corrective action procedure is filed with the project records.

Investigations initiated by laboratory technical or QA personnel that result in corrective actions must be documented and reported to the Tetra Tech START QA officer. Documentation of investigations of poor results on performance evaluation samples and corrective actions taken will be forwarded to the appropriate certifying agencies when required.

QAPP WORKSHEET #33
QA MANAGEMENT REPORTS

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Name, Title, Organization)	Report Recipient(s) (Title and Organization)
Monthly progress report	Monthly for all active TDDs	By the 20^{th} of the following month	Tetra Tech project manager	EPA on-scene coordinator, project officer, and contracting officer
Annual quality report	Annual	Within 1 month of contract anniversary dates	Tetra Tech QA officer	Tetra Tech president, corporate QA manager; Tetra Tech START program manager

Requirements:

Effective management of environmental data collection requires timely assessment and review of measurement activities. Open communication, interaction, and feedback must also occur among all project participants, including the EPA Region 5 project officer and QA officer, the Tetra Tech START program manager and QA officer, the Tetra Tech project manager and technical staff, and subcontractors. Tetra Tech prepares monthly progress reports for each TDD under the START contract. These reports address any TDD-specific quality issues and facilitate timely communication of such issues.

At the contract level, the Tetra Tech START QA officer prepares an annual START contract quality report related to Tetra Tech's work on the contract. This report is distributed to Tetra Tech's president, Tetra Tech's corporate QA manager, the Tetra Tech START program manager, and, upon request, to EPA. The report will:

- Summarize the results of audits and management systems reviews that have been completed
- Describe the status of ongoing corrective actions or quality improvement opportunities
- Identify any TDD-specific, subcontractor, and contract-wide quality issues
- Outline plans to address quality issues
- Identify any corporate- or contract-level support that will be required to effectively address the issues

QAPP WORKSHEET #34
VERIFICATION (STEP 1) PROCESS

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Field notes/ logbook	Field notes will be reviewed internally and placed in the project file. A copy of the field notes may be attached to the final report.	Internal	Tetra Tech project manager
Field data	Manual data entries will be reviewed against hard copy field forms or logbook entries. Electronic uploads of field data will be checked against any available manually recorded data on field forms or in logbooks	Internal	Tetra Tech project manager, field team leader, or assigned personnel
Chain-of-custody forms	Chain-of-custody forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody form should be initialed by the reviewer, a copy of the chain-of-custody form should be retained in the project file, and the original and remaining copies should be taped inside the cooler for shipment.	Internal	Tetra Tech field team leader
Sample receipt	For samples shipped by commercial carrier, Tetra Tech will confirm that samples were received by the laboratory on the date following shipment	Internal	Tetra Tech project manager, field team leader, or assigned personnel
Laboratory data packages	Laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Internal	EPA Region 5 Central Regional Laboratory (CRL), Contract Laboratory Program (CLP) laboratory, or subcontracted laboratory project manager
Laboratory data	All laboratory data packages will be verified externally for completeness and technical accuracy prior in accordance with the data validation procedures specified in Worksheet #35.	Internal	EPA Environmental Services Assistance Team (ESAT) contractor for data generated by CRL or CLP laboratories; Tetra Tech chemist for data generated by subcontracted laboratories

Requirements:

Data reduction, review, and verification are essential functions for preparing data that can be effectively used to support project decisions and DQOs. These functions must be performed accurately and according to EPA-approved procedures and techniques and region-specific guidelines. Data reduction includes computations and data manipulations that produce the final results used during the investigation. Data review and verification includes procedures conducted by field or laboratory personnel to ensure that measurement results are correct and acceptable relative to QA objectives in this QAPP and in any site-specific SAP. Because the types of field measurements and laboratory measurements used will vary with each site investigation, specific data reduction, review, and verification procedures and requirements cannot be addressed directly in this QAPP. However, many field and laboratory measurement data reduction, review, and verification procedures and requirements are specified in field and laboratory methods, SOPs, and guidance documents. In most cases, data review, reduction, and verification procedures can be identified in site-specific SAP by referencing these sources. However, if data review, reduction, and verification are not adequately described in these sources, the site-specific SAP should include the following information:

QAPP WORKSHEET #34
VERIFICATION (STEP 1) PROCESS

- Data review and reduction procedures for all phases of sample preparation and analysis (including procedures for data that are reduced and stored on a computer)
- Field personnel and laboratory personnel responsible for conducting each phase of data review and reduction
- Formulas and equations used during data reduction, including equations used to produce final results
- The definitions of terms and parameters
- The units for parameters and results
- Instructions on how results from QC samples (such as blanks) will be treated and used in calculating final results
- Procedures for flagging, qualifying, or marking the data with labels
- Corrective action procedures for instances when data reduction procedures are not followed correctly or when errors are found during data review

Field personnel will record all raw data from chemical and physical field measurements on field forms, in a field logbook, or using one of the electronic data collection tools described in Worksheet #27. Tetra Tech project managers have primary responsibility for (1) verifying that field measurements were made correctly, (2) confirming that sample collection and handling procedures specified in the site-specific SAP were followed, and (3) ensuring that field data reduction and review procedures and requirements are followed. They are also responsible for assessing preliminary data quality and for advising data users of potential QA/QC problems with field data. When field data are used in a project report, data reduction methods will be fully documented in the report.

Each laboratory will complete data reduction for chemical and physical measurements and will complete an in-house review of laboratory analytical results. The laboratory QA manager and project manager are responsible for ensuring that laboratory data reduction and review procedures and requirements in this QAPP and in the site-specific SAP are followed. The laboratory QA manager and project manager are also responsible for assessing data quality and for advising the Tetra Tech START QA officer and project manager of possible QA/QC problems with laboratory data.

QAPP WORKSHEET #35
VALIDATION (STEPS IIA AND IIB) PROCESS

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Chain of custody	Examine chain of custody records to verify the traceability of the data from time of sample collection until reporting.	EPA ESAT contractor for data generated by EPA Region 5 CRL or CLP laboratories Tetra Tech chemist for data generated by subcontracted laboratories
IIa	Holding times	Confirm that holding time requirements are met. If holding times were not met, confirm that deviations were documented, and that appropriate notifications were made.	
IIa	Analytical methods	Confirm that analytical methods specified in the site-specific SAP were used and that any deviations were noted. Verify that the QC samples met performance criteria or that any deviations were documented.	
IIa	Instrument calibration	Confirm that instrument calibration requirements were met.	
IIa	Laboratory data qualifiers	Verify that laboratory data qualifiers were defined and applied as specified in methods or laboratory SOPs.	
IIb	Project quantitation limits	Verify that quantitation limits in the site-specific SAP were achieved and that the laboratory successfully analyzed a standard at the quantitation limit.	
IIb	Field duplicate sample results	If field duplicate samples were analyzed, verify that the results meet RPD limits specified in the site-specific SAP.	
IIb	Performance criteria	Confirm that QC samples meet project-specific performance criteria and document any deviations.	

Notes:

CLP Contract Laboratory Program
CRL Central Regional Laboratory
ESAT Environmental Services Assistance Team
QC Quality control
SAP Sampling and analysis plan
SOP Standard operating procedure

Requirements:

Data used to support activities under the START contract must be valid for their intended purposes. This worksheet outlines the basic data validation procedures that will be followed for field and laboratory measurements. The following subsections identify personnel responsible for data validation and the general data validation process that will be followed.

QAPP WORKSHEET #35 (CONTINUED)
VALIDATION (STEPS IIA AND IIB) PROCESS

Data Validation Responsibilities: When required under a TDD, the Tetra Tech START QA officer, or her designee, is responsible for validating field and laboratory data. Tetra Tech will typically validate laboratory data produced by subcontractor laboratories. Data validation will be completed by one or more experienced data reviewers (typically a Tetra Tech chemist). Data produced by EPA laboratories will typically be validated internally be EPA or by the Region 5 Environmental Services Assistance Team (ESAT) contractor.

Data Validation Procedures: The validity of a set of data is determined by comparing the data with a predetermined set of QC limits. For investigations conducted under the START contract, these QC limits will be provided or referenced in each site-specific SAP. Tetra Tech data reviewers will conduct a systematic review of the data for compliance with established QC limits (for example, sensitivity, precision, and accuracy) based on spike, duplicate, and blank sample results provided by the laboratory. The data review will identify any out-of-control data points or omissions. Tetra Tech data reviewers will evaluate laboratory data for compliance with the following:

- Method and project-specific analytical service requests
- Holding times
- Initial and continuing calibration acceptance criteria
- Field, trip, and method blank acceptance criteria
- Surrogate recovery
- Field duplicates, MS/MSD, and matrix duplicate acceptance criteria
- Other laboratory QC criteria specified by the method and the project-specific analytical service request
- Compound identification and quantitation
- Overall assessment of data in accordance with project-specific objectives

Data validation requirements will depend on DQOs, region-specific guidelines, reporting requirements, and data deliverables requested from the laboratory. Data validation requirements presented in this worksheet may be referenced in the site-specific SAP to ensure consistency.

QAPP WORKSHEET #36
VALIDATION (STEPS IIA AND IIB) SUMMARY TABLE

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (Title and Organization)
IIa/IIb	Water	VOCs	Trace, low	NFG for Superfund Organic Methods Data Review	EPA ESAT contractor for data generated by EPA Region 5 CRL or CLP laboratories Tetra Tech chemist for data generated by subcontracted laboratories
		SVOCs	SIM, low	NFG for Superfund Organic Methods Data Review	
		Pesticides	NA	NFG for Superfund Organic Methods Data Review	
		Herbicides	NA	NFG for Superfund Organic Methods Data Review	
		PCBs	NA	NFG for Superfund Organic Methods Data Review	
		Dioxins/furans	NA	NFG for CDD and CDF Data Review	
		Metals	ICP-AES, ICP-MS	NFG for Inorganic Superfund Data Review	
		Mercury	NA	NFG for Inorganic Superfund Data Review	
		Cyanide	NA	NFG for Inorganic Superfund Data Review	
IIa/IIb	Soil, sediment, waste	VOCs	Low, medium	NFG for Superfund Organic Methods Data Review	
		SVOCs	Low, medium	NFG for Superfund Organic Methods Data Review	
		Pesticides	NA	NFG for Superfund Organic Methods Data Review	
		Herbicides	NA	NFG for Superfund Organic Methods Data Review	
		PCBs	NA	NFG for Superfund Organic Methods Data Review	
		Dioxins/furans	NA	NFG for CDD and CDF Data Review	
		Metals	ICP-AES, ICP-MS	NFG for Inorganic Superfund Data Review	
		Mercury	NA	NFG for Inorganic Superfund Data Review	
		Cyanide	NA	NFG for Inorganic Superfund Data Review	
IIa/IIb	Air	VOCs	NA	NFG for Superfund Organic Methods Data Review	

Notes:

CDD	Chlorinated dibenzo-p-dioxin
CDF	Chlorinated dibenzofuran
CLP	Contract Laboratory Program
CRL	Central Regional Laboratory
ESAT	Environmental Services Assistance Team
NA	Not applicable
NFG	National Functional Guidelines
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
PCB	Polychlorinated biphenyl
SIM	Selected ion monitoring
SVOC	Semivolatile organic compound
TDD	Technical direction document
VOC	Volatile organic compound

QAPP WORKSHEET #36 (CONTINUED)
VALIDATION (STEPS IIA AND IIB) SUMMARY

Requirements:

Tetra Tech will follow the most current EPA guidelines for completing data validation:

- U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2014a)
- U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014b)
- U.S. EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review (EPA 2011)
- U.S. EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009a)

General procedures in the EPA guidelines will be modified as necessary to fit the specific analytical method used to produce the data.
Tetra Tech will prepare brief reports to document the results of data validation. Data validation reports will be submitted to the Tetra Tech project manager and will include the following information:

- A summary of the analytical data that were validated
- The data validation guidelines that were used
- The specific criteria that were evaluated (such as initial and continuing calibration results, blank results, duplicate results, and sample quantitation results)
- Qualifiers that were applied to the data, and the reasons for application
- An overall assessment of data usability

The report will also include (as an attachment) a summary of the analytical results showing any data qualifiers that were applied.
If there are significant issues with the data, the project manager, with support from the data validator and Tetra Tech QA officer, will contact the laboratory to resolve the issues.

QAPP WORKSHEET #37
USABILITY ASSESSMENT

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Tetra Tech's process for evaluating data usability includes the data review, verification, and validation procedures outlined in Worksheets # 34, 35, and 36. As part of this effort, Tetra Tech will evaluate the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data using the methods described below. Finally, Tetra Tech will evaluate whether the data achieve the data quality objectives (DQO) that were established at the beginning of the project. **<u>Precision and Accuracy</u>:** Precision is a measure of the variability of a measurement system. Precision is typically estimated by means of duplicate and replicate measurements and is expressed in terms of relative percent difference (RPD). For field sampling, precision is increased by following standard operating procedures (SOP) and by collecting samples consistently, using the same sampling procedures. Field quality control (QC) samples collected to measure precision include field duplicate samples and collocated samples. Field measurement precision is monitored by taking replicate measurements, and is increased through proper operation and maintenance of field equipment. Precision for laboratory analyses will be measured by collecting and analyzing the following types of samples: matrix spike (MS) and matrix spike duplicate (MSD) samples, and laboratory control samples (LCS) and LCS duplicate (LCSD) samples. Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy is typically expressed as percent recovery (%R) from spiked samples or bias with respect to a reference standard. The use of spiked samples permits a check on method accuracy and helps evaluate whether the sample matrix affects analytical results. Accuracy for field sampling will be increased by establishing a sound sampling strategy and following appropriate SOPs. Field QC samples collected to measure accuracy include trip blanks, field blanks, and equipment rinsate blanks. In general, the accuracy of field measurements will be increased by following appropriate SOPs and through proper calibration and maintenance of equipment. QC measures used to monitor the accuracy of field measurements include checking instrument responses against calibration standards. Accuracy for laboratory analyses will be assessed by collecting and analyzing MS/MSD samples which are collected in the field. Other QC check samples used to assess accuracy are prepared in the laboratory and may include blank spikes, surrogate spikes, method blanks, reagent blanks, instrument blanks, calibration blanks, LCS, standard reference materials, and independent check standards. **<u>Representativeness, Completeness, and Comparability</u>:** Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that depends on the proper design of the sampling program and proper laboratory protocol. The sampling network for each investigation will be designed to provide data representative of environmental conditions. Representativeness can also be affected by the time, place, and manner by which the samples are collected. Project planners may account for the difficulty in knowing when, where, and how to collect representative samples by developing statistical or random sampling networks; collecting more samples than would otherwise be needed; collecting samples at several different phases of natural or anthropogenic cycles; sampling at different locations within the project area; collecting composite samples as opposed to grab samples; and verifying and validating the sampling techniques in separate studies. The site-specific SAP will identify specific methods for achieving and demonstrating the representativeness of the samples to be collected.

QAPP WORKSHEET #37 (CONTINUED)
USABILITY ASSESSMENT

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the total number of measurements necessary to achieve DQOs at a specified level of confidence. Following completion of data validation, the percent completeness will be calculated from the number of samples with valid data and the number of samples originally planned. QA objectives for completeness are directly related to DQOs and will be documented and explained in site-specific SAPs.

Comparability expresses the confidence with which one data set can be compared with another. Generally, comparability will be attained by achieving the QA objectives for accuracy, precision, completeness, and representativeness in the site-specific SAP. Comparability of data will also be achieved by following field and laboratory procedures consistently for individual investigations and for the START contract. EPA-approved field and laboratory procedures, such as those listed in Worksheets #21 and 23 will be used to the extent possible.

Reconciliation with User Requirements: The primary purpose of a quality system is to define a process for collecting data that is of known quality, is scientifically valid, is legally defensible, and fully supports any decisions that will be based on the data. To achieve this purpose, this QAPP requires that DQOs be fully defined as describe in Worksheets #10 and 11. All other parts of the quality system must then be planned and implemented in a manner consistent with the DQOs. Quality system components that follow directly from the DQOs include documentation and sample network design (Worksheet #17), sampling methods (Worksheet #21), analytical methods (Worksheet #23); field QC requirements (Worksheet #20); laboratory QC requirements (Worksheets #12 and 28), and data review, verification, and, validation methods (Worksheets #34, 35, and 36).

Once environmental data have been collected, reviewed, and validated, the data must be further evaluated to determine whether the DQOs identified in the site-specific SAP have been met. Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. The DQA process involves first verifying that the assumptions under which the data collection design and DQOs were developed have been met, or taking appropriate corrective action if the assumptions have not been met. The DQA process then evaluates how well the data collected support the decision that must be made so that scientifically valid and meaningful conclusions can be drawn from the data. To the extent possible, Tetra Tech will follow methods and procedures outlined in EPA's DQA guidance – *Data Quality Assessment: A Reviewer's Guide (EPA QA/G-9R and Data Quality Assessment: Statistical Methods for Practitioners (EPA QA/G-9S)* (EPA 2006b and 2006c).

If data quality indicators do not meet the project's requirements as outlined in the QAPP, the data may be rejected, and re-sampling and/or re-analysis may be required.

Identify the personnel responsible for performing the usability assessment:
Tetra Tech project managers and field team leaders have primary responsibility for review and verification of field data.
Tetra Tech will typically validate laboratory data produced by subcontractor laboratories. Data validation will be completed by one or more experienced data reviewers (typically a Tetra Tech chemist). Data produced by EPA laboratories will typically be validated internally be EPA or by the Region 5 Environmental Services Assistance Team (ESAT) contractor. Validation will include a review of the precision and accuracy of the data.

Tetra Tech project managers and project team members have primary responsibility for the final data usability assessment. This includes evaluating the completeness, representativeness, and comparability of the data and whether the quantity and quality of data collected are sufficient to meet DQOs.

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